U.S. Army Corps
Of Engineers

Kansas City District

QUALITY ASSURANCE PROJECT PLAN

Preliminary Assessment/Site Inspection Former St. Louis Ordnance Plant St. Louis, Missouri

Final Submittal

January 2001

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Consulting Engineers Scientists Architects

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Preliminary Assessment/Site Inspection of
Former St. Louis Ordnance Plant
St. Louis County, Missouri

ROUTING AND TRANSMITTAL SLIP Date 2/6/01

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LIST OF ACRONYM

%R	Percent Recovery
AA	Atomic Absorption
AM Lab	Analytical Management Laboratories, Inc.
APG	Analytical Products Group
ASTM	American Society for Testing and Materials
BS	Blank Spike
BSD	Blank Spike Duplicate
CDFR	Chemical Data Final Report
COC	Chain-of-Custody
CQAB Lab	Chemical Quality Assurance Branch Laboratory
CQAR	Chemical Quality Assurance Report
DO	Dissolved Oxygen
DQOs	Data Quality Objectives
ELPAT	Environmental Lead Proficiency Analytical Testing
FSP	Field Sampling Plan
GC/MS	Gas Chromatograph/Mass Spectrometer
Hanley	Hanley Industry, Inc.
HMX	Cyclotetramethylenetetranitramine
HRS	Hazard Ranking System
ICP	Inductively Coupled Plasma
ID	Identification
IDW	Investigation-Derived Waste
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LQAPP	Laboratory Quality Assurance Program Plan
MDL	Method Detection Limit
$\mu g/m^2$	micrograms per square meter
MDNR	Missouri Department of Natural Resources
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NASA	National Aeronautics and Space Administration
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Testing
ORP	Oxidation-Reduction Potential
PA/SI	Preliminary Assessment/ Site Inspection
PAH	Polynuclear Aromatic Hydrocarbon
PARCC	Precision, Accuracy, Representativeness, Completeness and Comparability
PCOCs	Potential Contaminants of concern
PETN	Pentaerythritol Tetranitrate
PREscore	Preliminary Ranking Evaluation Score
ppb	Part Per Billion
ppm	Part Per Million
PQL	Practical Quantitation Limit
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QCSR	Quality Control Summary Report
RDX	Cyclotrimethylenetrinitramine

LIST OF ACRONYM (continued)

RPD	Relative Percent Difference
RSD	Relative Standard Deviation
S	Standard Deviation
SAP	Sampling Analysis Plan
SOP	Standard Operating Procedure
SOW	Scope of Work
SQL	Sample Quantitation Limit
SRM	Standard Reference Materials
SSHP	Site Safety and Health Plan
SVOC	Semi Volatile Organic Compound
TAL	Target Analyte List
TapanAm	TapanAm Associates, Inc.
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds

1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION

This Quality Assurance Project Plan (QAPP) was prepared by TapanAm Associates, Inc. (TapanAm), for the U.S. Army Corps of Engineers (USACE), Kansas City District, for the former St. Louis Ordnance Plant (SLOP), located in St. Louis, Missouri. The draft QAPP was prepared in accordance to the revised Scope of Work (SOW) dated June 1999 under Contract Number DACW 41-94-D-9010, Delivery Order Number 002. However, the draft final QAPP has been revised to include the responses to the review comments and the modified SOW dated August 16, 2000. The modified scope required to conduct a field investigation that produces data to support completion of United States Environmental Protection Agency (USEPA) Preliminary Ranking Evaluation Score (PRE score) and Hazard Ranking System (HRS).

- This QAPP is one of the four documents that make up the work plan for the preliminary assessment/site inspections (PA/SI) at the SLOP site.

1.2 PURPOSE OF QUALITY ASSURANCE PROJECT PLAN

This QAPP describes the chemical data quality control limits, data quality objectives (DQOs), project organization, laboratory analytical procedures, and laboratory quality assurance/quality control (QA/QC) protocols necessary to achieve DQOs dictated by the intended use of the data. The QAPP provides description or reference to DQOs and procedures associated with sample collection, laboratory analyses, sample custody, instrument calibration, internal QC, performance and system audits, data quality assessment, corrective actions, and QA reports. A copy of the standard operating procedures (SOPs) for Analytical Management Laboratories, Inc. (AM Lab) is available at TapanAm's office.

1.3 SITE HISTORY

The former SLOP is located approximately 0.25 miles south of the intersection of Interstate 70 and Goodfellow Boulevard, St Louis, Missouri (Figure 1-1). The study area, also known as the Hazardous/Chemical Area No.2, which was a part of SLOP, and was used for explosive production and storage. The construction of the plant was completed in May 1942.

SCALE 1:24000

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Note: Topographic map is the USGS Clayton, MO. quadrangle map, 1954, photorevised 1993.

DESCRIPTION Site Location Map	
SITE NAME/LOCATION St. Louis Ordnance Plant	PROJECT NO. 1011.02
TapanAm Associates, Inc. Engineers Architects 201 W. 135th St., Suite 100 (816) 941-6100 Martin City, Missouri 64145-1201 FAX (816) 941-6002	FIGURE 1-1

During World War II, SLOP was operated for the production of small arms ammunition and components for the 105 millimeter shells. The study area consists of various production buildings, magazine storage bunkers, powder wells, underground rooms, tunnels for service utilities, sewer lines for wastewater system, and a storm-water collection system (Figure 1-2). Following deactivation of the plant in 1979, the buildings were decontaminated by the USACE. However, no records were available that described the procedures employed in the decontamination procedures.

1.4 PREVIOUS INVESTIGATIONS

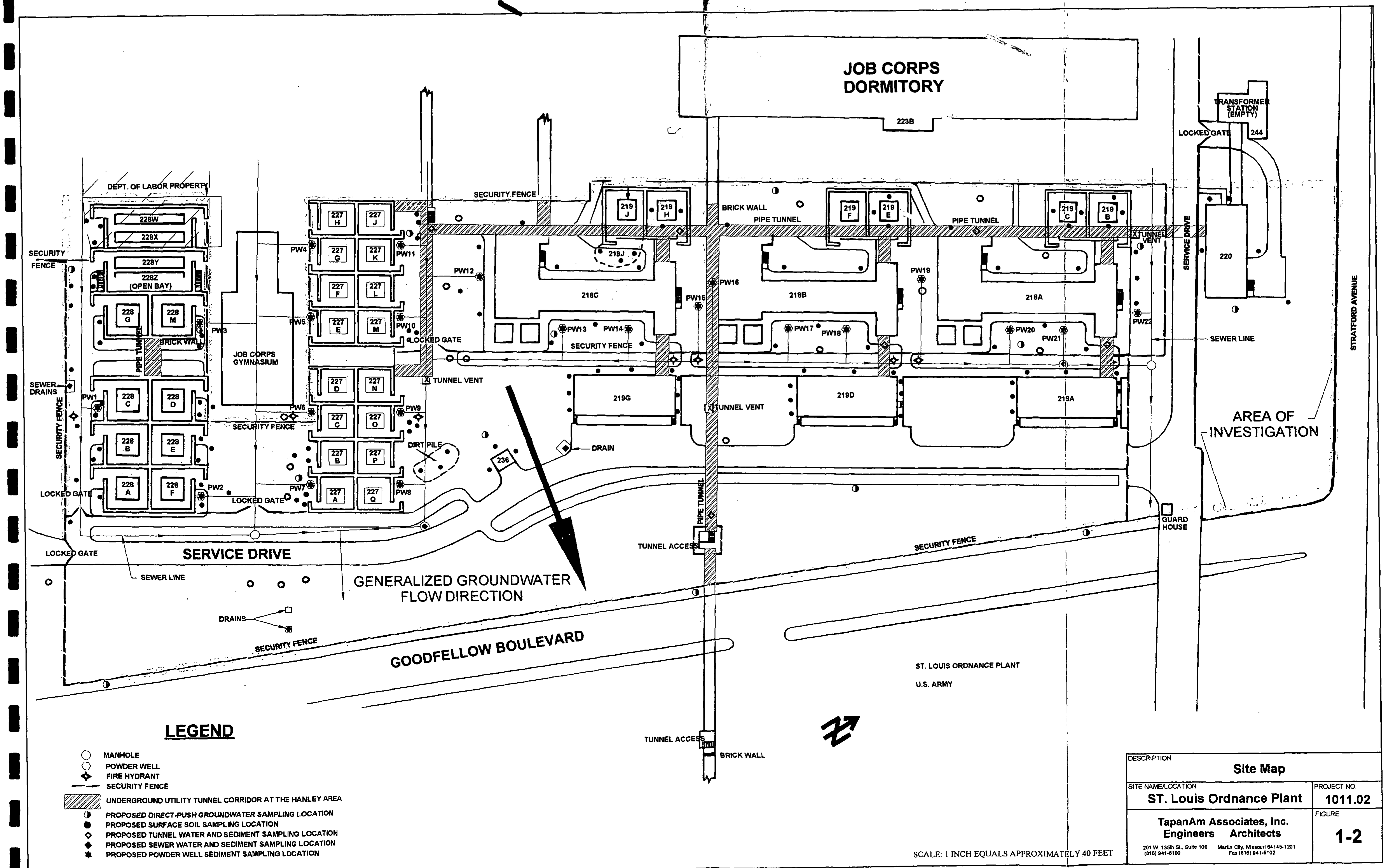
Three environmental investigations and one archive search report have been conducted at the former SLOP site, Hanley area. Previous investigations at the site include:

- "USATHAMA-Battelle Columbus Laboratories, June, 1981;
- "USATHAMA- Environmental Study", ICF Technology, Inc., November, 1991;
- "Site Investigation Report, Former SLOP, St. Louis, Missouri", Harza Environmental Services, Inc., December, 1998.

In 1981, Battelle surveyed the area for explosives and heavy metal contamination. ICF Technology, Inc. conducted a field screening survey to quantify the extent of asbestos and soil contamination in 1991. The USACE compiled an archives search report for SLOP in 1993. Further field investigation was performed by Harza in 1998. The results of the field sampling activities are described in the following sections.

1.4.1 USATHAMA-Battelle Columbus Laboratories, 1981

In 1981, Battelle surveyed the area for explosives and heavy metal contamination in and around 7 buildings, 54 magazines, 28 powder wells, and 5 sewer locations. The findings showed heavy metal residues to be present on the interior surfaces of all buildings and in the aqueous discharge of the sewer system. Additionally, explosive residues were found on the interior of several buildings and magazines and in the water of several powder wells draining buildings 218A and 218B. Swipe samples for heavy metal analyses were composited by building number and magazine group and were reported in micrograms per square meter ($\mu g/m^2$). Heavy metal concentrations ranged from below detectable limits to 24, 147, 32, and 102 $\mu g/m^2$ for silver, nickel, mercury, and cadmium, respectively. Lead and chromium were found in all of the buildings surveyed. Concentrations of chromium ranged from 26 to 515 $\mu g/m^2$. Lead concentrations ranged from 800 to 27,200 $\mu g/m^2$. Magazine 219E housed Hanley's lead azide reactor. Magazine 219F, used for open burning of


JOB CORPS DORMITORY
223B
TRANSFORMER STATION (EMPTY)
244
LOCKED GATE
DEPT. OF LABOR PROPERTY
SECURITY FENCE
BRICK WALL
PIPE TUNNEL
TUNNEL VENT
SERVICE DRIVE
220
228W
228X
228Y
228Z (OPEN BAY)
JOB CORPS GYMNASIUM
219J
218C
218B
218A
219G
219D
219A
236
DIRT PILE
DRAIN
DRAINS
SEWER DRAINS
SEWER LINE
GUARD HOUSE
TUNNEL ACCESS
AREA OF INVESTIGATION
STRATFORD AVENUE
SERVICE DRIVE
GENERALIZED GROUNDWATER FLOW DIRECTION
GOODFELLOW BOULEVARD
ST. LOUIS ORDNANCE PLANT
U.S. ARMY
LEGEND
MANHOLE
POWDER WELL
FIRE HYDRANT
SECURITY FENCE
UNDERGROUND UTILITY TUNNEL CORRIDOR AT THE HANLEY AREA
PROPOSED DIRECT-PUSH GROUNDWATER SAMPLING LOCATION
PROPOSED SURFACE SOIL SAMPLING LOCATION
PROPOSED TUNNEL WATER AND SEDIMENT SAMPLING LOCATION
PROPOSED SEWER WATER AND SEDIMENT SAMPLING LOCATION
PROPOSED POWDER WELL SEDIMENT SAMPLING LOCATION
SCALE: 1 INCH EQUALS APPROXIMATELY 40 FEET
DESCRIPTION
Site Map
SITE NAME/LOCATION
ST. Louis Ordnance Plant
PROJECT NO.
1011.02
TapanAm Associates, Inc.
Engineers Architects
FIGURE
1-2

explosives, had the highest lead concentration of 5,840 mg/kg. Concentrations of silver, mercury, and chromium were below detectable limits in all sewer samples.

Explosive residues were found on the walls in buildings 218A, 218B, 218C and 220 as well as Magazines 219C, 219H, 227J, 227M, 227O, 228C, and 228F. Explosive residues were also found in the standing water present in the powder wells draining buildings 218A and 218B. No explosives were found in the discharge of the sewer system. The presence of explosive residues in 218A, 218B, and 218C coincides with the explosive loading, mixing, and disposal operations that were conducted in these buildings from 1941 to 1979. Magazines 219C, 219H, 228C, and 228F were found to contain trace amounts of Cyclotetramethylenetetranitramine (HMX) in residues sampled from the magazine interiors. The explosive chemical 2,4,6-Trinitrophenylmethylnitramine (Tetryl) was found in the water from the 7 powder wells draining buildings 218A and 218B with levels 4.0 and 4.6 ppb, respectively (Battelle, 1981).

1.4.2 USATHAMA- Environmental Study, ICF Technology, Inc., 1991

In 1991, ICF collected 29 surface soil samples across the site to evaluate the presence of contamination potentially affecting surface runoff and groundwater. Two water samples were collected within the tunnel system to evaluate surface runoff. Results of the sampling indicated that surface soils are contaminated with lead at levels of concern. Contaminant migration pathways for lead include surface runoff and windblown dust. Water samples collected from the tunnels were contaminated with lead and an explosive, pentaerythritol tetranitrate (PETN) at a level of 20 micrograms per liter (μg/L), which was also the method reporting limit. Asbestos containing materials were found to be present in most areas within the Hanley area. A leaking transformer containing high levels of polychlorinated biphenyls (PCBs) was dismounted, protectively wrapped, and was disposed of along with PCB-contaminated soils.

Recommendations included the appropriate management of asbestos in the Hanley area and characterization of powder wells and associated piping for the presence of contamination.

1.4.3 Site Investigation Report, Former SLOP, St. Louis, Missouri, Harza Environmental Services, Inc., 1998

In 1998, Harza collected 21 surface soil samples, 4 sediment samples from the powder wells and sewer system, and 1 water sample from a powder well. The samples were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), explosives, and metals.

Explosives contaminants were detected outside building 219F at concentrations of 3,300 and 9,730 micrograms per kilogram (µg/kg) Cyclotrimethylenetrinitramine (RDX) and 1,480 and 1,700 µg/kg HMX at 0-1 foot and 1-2 feet, respectively.

Metals found in surface samples include arsenic, barium, cadmium, chromium, lead, mercury, and silver. Principal organic compounds that were detected by SVOC analyses are polynuclear aromatic hydrocarbons (PAHs) such as phenanthrene, antracene, flouranthene compounds, pyrene compounds, benzo(a) anthracene, chrysene, and bis(2-ethylhehl)phthalate.

ICF, 1991, states that SVOCs "were observed at trace levels (< 1 ppm) in the background soil samples" and that "their presence is probably due to the proximity of the sampling locations to an asphalt parking lot". For the non-background samples ICF states that "The PAHs were detected at low levels, probably attributable to constituents present in the fill material". Harza, 1998, stated that SVOC contamination "may not result from past operations at the SLOP'. Therefore, no SVOC anaylses are planned for this PA/SI.

1.5 POTENTIAL CONTAMINANTS OF CONCERN (PCOCs)

From 1959-1979, Hanley Industries, Inc. (Hanley) leased 14.68 acres of the Hazardous/Chemical Area No. 2 for production operations such as synthesis, receiving, drying, screening, mixing, loading, pressing and testing of explosives (Table 1-1). Hanley did considerable work in the design of explosive trains and components. The explosive compounds utilized by Hanley Industries are listed in Table 1-2. Additionally, explosive components were loaded for the military, and the National Aeronautics and Space Administration (NASA). Most of Hanley's buildings were used for loading detonators and primers and for explosive mixing (Table 1-1). Explosives were dried in Magazines 219C, B, F, J, and H by leaving cans of explosives without lids exposed to the air. Hanley operated a lead azide reactor in magazine 219E. Feed tanks were located just outside the concrete wall. Two feed lines for the conveyance of sodium azide and lead nitrate ran via overhead supports from the tanks to the reactor (two pumps were used). The tanks, feed lines, and reactor have been removed. Table 1-1 lists the building usage during Hanley's lease. The PCOCs within the study area include explosives, VOCs, and heavy metals (Table 1-3).

Methylene chloride and toluene are the only VOCs detected on site. Methylene chloride was detected at 25.7 μg/kg in soil at building 236 and toluene was detected at 3 μg/kg in soil at Magazine 219J. Based on the past site operations, the Hanley Industries would have used organic solvents as cleaning agents and paint thinners. The organic compounds likely to be present include: 1,1-dichloroethane, benzene, carbon tetrachloride, chloroethane, chloroform, ethylbenzene, methylene chloride, tetrachloroethene, toluene, and trichloroethylene.

Table 1-1. Hanley Industries Building Usage

Building	Rooms/Area	Usage
220	All rooms except basement	Loading and Mixing of Explosives
218A	102, 104, 105, 106, 107, 108, 109, 110, 111, 113, 117, 121, 123. All other rooms	Loading and Mixing of Explosives. Delay powder loaded in basement under Room 105. Non-explosive storage.
218B	110, 113, 115, 119, 123, 125, 127, 128-1, 128-2, 128-3, 128-4, 132. Basement	Loading and Mixing of Explosives Empty as non-explosive storage
218C	104. Basement	Loading and Mixing of Explosives Burning of explosive contaminated rags.
219A	Lab Building	Primer and tracer mixing,, loading smokeless powder
219B		Air drying of explosives
219C		Air drying of explosives.
219D	Lab Building	Primer and tracer mixing,, loading smokeless powder
219E		Lead azide production
219F		Burning of explosives
219G	Lab Building	Primer and tracer mixing,, loading smokeless powder
219H		Air drying of explosives
219J		Burning of explosives
236	Garage	Maintenance
	Sewer Lines	Receive waste water from buildings and powder wells
	Powder Wells	Provide sedimentation control before discharge to the sanitary sewer
220	Lab Building	Explosives laboratory
227-228	All other magazines	Storage of explosives in sealed containers

Table 1-2. Hanley Industries Explosive Compounds Utilized

Lead Styphanate
Tetryl (2,4,6-Trinitrophenylmethylnitramine)
RDX (Cyclotrimethylenetrinitramine)
NOL 130 (Ignition mix). Primer mix having the following composition: ♦ 20% lead azide; 15% antimony sulfide; 20% barium nitrate; 40% lead styphnate; and 5% tetracene
A180 (Ignition mix)
Black Powder
HMX (Cyclotetramethylenetetranitramine)
NOL 60 (Ignition mix). Primer mix having the following composition: ♦ 10% antimony sulfide; 25% barium nitrate; 40% lead styphnate; and 5% tetracene
PETN (Pentaerythrite Tetranitrate)
Tetracene
Silver azide
Smokeless powder
Trinitroresocinol
Diazodinitrophenol
Delay powder (Dependent on the composition used, may contain the following compounds: ♦ Barium chromate; zirconium powder; nickel powder; potassium perchlorate; red lead; silicon powder, lead chromate, and manganese powder).
Lead nitrate
Sodium azide

Table 1-3. SLOP Chemicals of Concern

Chemicals of Concern	Previous Maximum Concentrations Detected	Matrix/Sample Location
VOCs		
1,1-dichloroethane	N.D.[1]	N.A.[2]
Benzene	N.D.	N.A.
Carbon Tetrachloride	N.D.	N.A.
Chloroethane	N.D.	N.A.
Chloroform	N.D.	N.A.
Ethylbenzene	N.D.	N.A.
Methylene Chloride	25.7 μg/kg[3]	Soil/Building 236
Tetrachloroethene	N.D.	N.A.
Toluene	3 μg/kg	Soil/Magazine 219J
Trichloroethylene	N.D.	N.A.
METALS		
Cadmium	5.2 μg/g[4]	Sewer/Between Buildings 218A and 218B
Chromium	57.8 μg/g	Soil/Magazine 227M
Lead	5,840 mg/kg[5]	Soil/Magazine 219F
Mercury	0.33 mg/kg	Sewer/Between Buildings 218A and 218B
Nickel	32.2 μg/g	Soil/Magazine 227M
Silver	82.6 μg/g	Soil/Magazine 219E
Vanadium	51.1 μg/g	Soil/Building 220
Zinc	221 μg/g	Soil/West courtyard of Building 218C

EXPLOSIVES		
2,4,6-Trinitrophenylmethylnitramine (Tetryl)	4.0-4.6 ppb	Water/218A and 218B Powder Wells.
Cyclotetramethylenetetranitramine (HMX)	1,700 mg/kg	Soil/Magazine 217F
Cyclotrimethylenetrinitramine (RDX)	8,730 mg/kg	Soil/Magazine 217F

Note:

N.D.[1]– Not Detected
N.A[2]– Not Applicable
µg/kg[3]– micrograms per kilogram
µg/g[4]– micrograms per kilogram
mg/kg[5]– milligrams per kilogram

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The project organization, key personnel, and their responsibilities are described in Section 2.0 of the Field Sampling Plan (FSP). This section of the report describes the personnel and subcontractors responsible for project chemical data acquisition and QC. The primary laboratory selected for this project is Analytical Management Laboratories, Inc. (AM Lab), located in Olathe, Kansas. Table 2-1 lists the key personnel and their contact information. Chart 2-1 shows the line of the QC organization and each QC personnel responsibilities.

2.1 PRIMARY LABORATORY

AM Lab will be responsible for providing sample shipping containers, chain-of-custody (COC) documents, chemical analyses and reporting, and laboratory QA/QC. Am Lab will perform analyses of VOCs, TAL metals, and explosives. AM Lab has integrated QA/QC procedures into their standard operating procedures and is certified by USACE. The laboratory QAPP from AM Lab is available for reference at TapanAm's office. AM Lab will report directly to the TapanAm project manager during all phases of the work.

2.2 LABORATORY PERSONNEL QUALIFICATIONS

Responsibilities and minimum experience requirements for the primary laboratory personnel are listed below:

Laboratory Manager – Bill Said

Bill Said has 15 years of experience in environmental analytical laboratory procedures. From 1990 to 1994, Mr. Said worked as a Senior Chemist at the USEPA Region VII laboratory in Kansas City, Missouri. He has been the Laboratory Manager of AM Lab since 1994. He is responsible for ensuring that all analytical tasks for this project are conducted in accordance to the requirements of this QAPP. He is responsible for maintaining accurate standard operating procedures (SOPs) and enforcing their use in the laboratory.

Laboratory Quality Assurance Manager – Vis Viswanathan, Ph.D

Dr. Viswanathan, manager of the QA program, is responsible for overseeing the QA aspects of the data and is also the point of contact for this project. From 1989 to 1995, he provided laboratory technical assistance and managed various government contracts at Professional Service Industries, Inc., Lawrence, Kansas. From 1983 to 1989, he provided technical assistance and managed various government contracts at EPA Region VII. From 1975 to 1983, he held various research and teaching appointments at various universities.

Section Supervisors

The supervisors are responsible for all technical efforts of their respective sections to meet all terms and conditions for this project. These individuals will have a minimum of a bachelor's degree in chemistry. A minimum of three years of laboratory experience, including at least one year of supervisory experience is required. The section supervisors report to Bill Said who is the Laboratory Manager.

Gas Chromatography/Mass Spectrometer Operators

Qualifications for these individuals will be a minimum of one year of experience in operating and maintaining Gas Chromatographs/Mass Spectrometers and in performing the required analyses such as VOCs and SVOCs. A bachelor's degree in chemistry is or equivalent experience in chemistry is required.

Inductively Coupled Plasma Operators

Qualifications for these individuals will be minimum of one year of experience in operating and maintaining the inductively coupled plasma (ICP) and a bachelor's degree or equivalent experience in chemistry is required.

Atomic Absorption Analysts

Qualifications for these individuals will be a minimum of one year of experience in operating and maintaining the equipment necessary to analyze for mercury using the cold-vapor atomic absorption (AA) method and a bachelor's degree or equivalent experience in chemistry is required.

Sample Preparation Chemists

Qualifications of these individuals will be a minimum of high school diploma with chemistry courses. A bachelor's degree in chemistry or any related scientific discipline or equivalent is desirable. These individuals will have a minimum of one year of experience with classical chemistry laboratory procedures in conjunction with educational qualifications.

Chart 2-1. Project Organizational Chart for Key Personnel and Chemical Quality Control Responsibilities

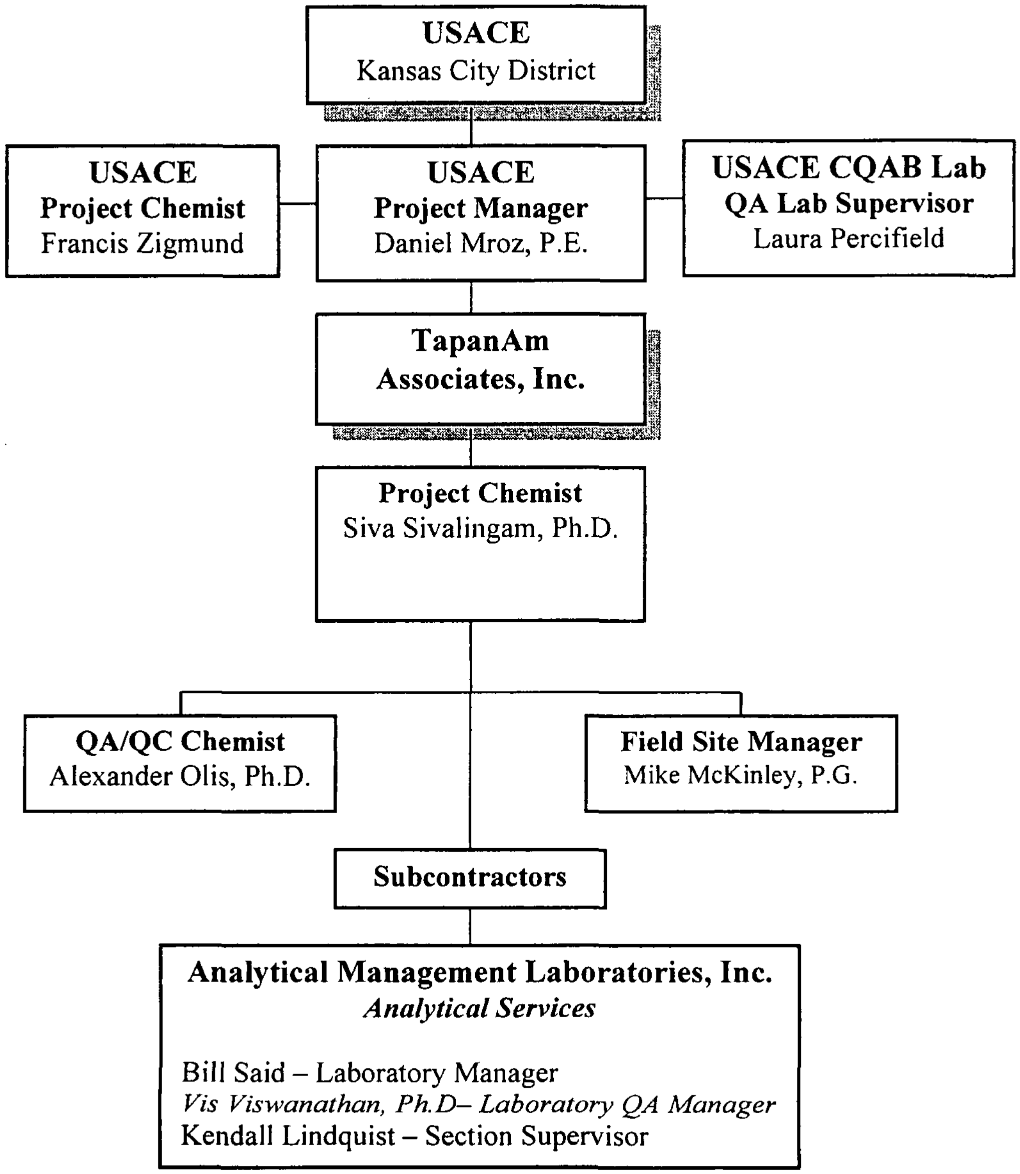


Table 2-1. Summary of Key Personnel and Contact Information

Role	Key Personnel/ Telephone Number	Organization	Responsibilities
Project Manager	**Daniel Mroz, P.E.** (816) 983-3368	**USACE** Kansas City	Project Management
Project Chemist	**Francis Zigmund** (816) 983-3905	**USACE** Kansas City	Responsible for report review and overall chemical data quality
QA Laboratory Supervisor	**Laura Percifield** (402) 444-4313	**CQAB Lab** Omaha	Contract Management
Project Manager/Chemist	**Siva Sivalingam, Ph.D.** (816)941-6100	**TapanAm**	Prepare QAPP, chemical DQO, and project DQO
QA/QC Chemist	**Alexander Olis, Ph.D.** (904) 542- 2717	**TapanAm**	Chemistry review and data validation
Field Chemist	**Kyle Madden** (816) 941-6100	**TapanAm**	Oversees field sampling in accordance with QAPP
Field Site Manager	**Mike Mckinley, P.G.** (816) 941-6100	**TapanAm**	Oversees field sampling activities
Laboratory Manager	***Bill Said*** (913) 829-0101	**Analytical Management Lab., Inc.**	Management and adherence to SOP and QAPP
Laboratory QA Manager	**Vis Viswanathan, Ph.D.** (913) 829- 0101	**Analytical Management Lab., Inc.**	Oversees the QA aspect of laboratory data
Section Supervisor	**Kendall Lindquist** (913) 829- 0101	**Analytical Management Lab., Inc.**	Supervise technical aspect of each section of laboratory analysis

3.0 DATA QUALITY OBJECTIVES

Quality control limits and DQOs have been developed for the project to ensure that analytical data collected during the field investigations will be of sufficient quality to support the data's intended use. DQOs are qualitative or quantitative statements developed by the data user to specify the quality of data needed from a particular data activity to support specific decisions (USEPA, 1993).

3.1 PROJECT OBJECTIVES

The project objectives are to collect analytical data of sufficient quality to support the following tasks:

- Characterize and evaluate significant site sources;
- Characterize and evaluate significant pathways;
- Evaluate releases and targets exposed to contamination;
- Collect sufficient data to support HRS (PREscore);

3.2 FIELD INVESTIGATIONS

The proposed scope for the field investigation work for implementation of the PA/SI includes the following task descriptions:

- Surface Soil Investigations: Sampling of surface soils of the Hanley area to assess contamination from explosives, VOCs, and heavy metals. Both grab and composite samples will be collected around the buildings and magazines. It is expected that up 62 analytical samples will be collected for metals and explosives, and 24 samples for VOCs.

- Sewer Sediments: Six sewer sediments will be collected within the at sewer system and one sewer sediment collected upgradient. A sampling device with a long handle will be lowered through the manhole to collect the sewer sediment samples. The samples will be analyzed for explosives, metals, and VOCs.

- Tunnel Sediment/Water: Six tunnel sediment and 6 tunnel water samples will be collected inside the former utility tunnel system below the Hanley area. The sediment samples will be taken at areas where there appears to be significant accumulation of sediment. Tunnel water samples will be collected where liquid is found in the tunnel system. The samples will be collected from the same location if possible and analyzed for explosives and metals.

- Powder Sump Sediments: It is expected that up to 22 sediment samples will be collected for explosives and metals analyses. EOD Technology, Inc (subcontractor) will collect the powder well sump sediment samples. The sampling procedures and health and safety plan are provided as a separate document.

- Subsurface Samples: Subsurface samples will be collected adjacent to cracks in sewer lines and in powder well sumps. The cracks in the sewer line will be determined using a remote entry video camera. The cracks in the powder well sumps will be visually observed during powder well sediment sampling. Five subsurface samples will be collected and analyzed for explosives, metals, and VOCs.

- Direct-Push Groundwater Investigation: Sixteen temporary piezometers will be installed using direct-push methods. Groundwater samples from the temporary piezometers will be analyzed for explosives, metals, and VOCs. Based on the analytical results from the direct-push groundwater samples, 6 permanent monitoring wells may be installed using hollow-stem augers. Other activities include: water level measurements from temporary piezometers and permanent monitoring wells; instrumental measurements of physical and chemical parameters during purging and low-flow sampling of groundwater monitoring wells; collection and off-site laboratory analyses of 6 groundwater samples from the monitoring wells;

- Management of Investigation-Derived Waste (IDW): Soil and water samples will be collected and analyzed for explosives, metals, and VOCs prior to disposal.

3.3 SPECIFIC DATA TYPES

Based on USEPA's DQO Guidance Document (USEPA, 1993), two types of data that will be generated for SLOP site. These are described below:

Field Screening

Measurement data generated during this project will conform to screening data for water quality parameters such as pH, oxidation-reduction potential (ORP), turbidity, dissolved oxygen (DO), and conductivity using a flow-through cell ,YSI 6820.

Definitive Data

Analytical results from environmental samples sent to AM Lab and analyzed using USEPA reference methods will conform to Level III definitive data requirements. The approach to providing reliable data that meet the DQOs will include QA/QC requirements for each of the analytical data types generated during the field investigation. Laboratory analyses proposed for soil and groundwater include VOCs, TAL metals, and explosives.

3.4 EVALUATION OF PARCC PARAMETERS

Parameters used within the data validation process to evaluate data quality include determination of data quality with respect to precision, accuracy, representativeness, completeness, and comparability (PARCC) and sensitivity.

The control limits for these parameters vary with the type of data. The objectives used for laboratory analytical data in this program will be those set by the project needs. The specific PARCC parameters applicable to field and laboratory data for this project are summarized in Tables 3-1 through 3-13 The PARCC parameters are defined below:

Precision

Precision is evaluated using the Relative Percent Difference (RPD) between the results of a laboratory spiked sample such as matrix spike (MS) and a duplicate laboratory spiked sample like matrix spike duplicate (MSD). Precision may also be evaluated using the RPD between the results of a laboratory spiked blank sample such as blank spike (BS) and a duplicate laboratory spiked blank sample such as blank spike duplicate (BSD). Similarly, laboratory precision may also be evaluated using RPD between laboratory control samples (LCS) and laboratory control sample duplicate (LCSD). Precision for the field work is evaluated using the RPD between the results of field replicate samples. The formula for calculating the RPD is given in Section 9.1.

Accuracy

Accuracy will be evaluated using control samples aimed at detecting positive and negative bias in sampling and analyses. Negative controls include the analyses of various blank samples such as trip blanks, field blanks, equipment rinsate blanks, and laboratory method blanks. If analyte not expected to be present is detected in any of these blanks, positive results for such analytes will require evaluation through standardized data validation procedures. Positive controls include the analysis of spiked samples/blanks and the analyses of samples containing known amounts of target analytes. Accuracy will be evaluated from the percent recoveries of spiked analytes in MS/MSD's, surrogate compounds, laboratory BS samples and/or LCS. The proposed accuracy criterion for this project is shown in Tables 3-1 through 3-13. The formula for calculating the RPD is given in Section 9.2.

Representativeness

Representativeness qualitatively expresses the extent to which sample data accurately and precisely represent the characteristics of a population of samples, parameter variations at a sampling point, or an environmental condition. Representativeness is most concerned with the proper design of the sampling program and use of appropriate standardized sample collection, homogenization, preservation, and analytical methods. Adherence to SOP procedures for sample collection and analyses, as well as performing analyses within the technical holding times, are procedures to be followed to maximize representativeness. Representativeness will be evaluated using criteria such as adherence to holding times, results for field duplicates, rinsate blanks, method blanks, and laboratory duplicate results.

The examination of field duplicate results will provide a measure of assurance that the samples collected are representative of the sampling points. Method blanks and rinsate blanks will be used to determine the entry of contaminants in the field/laboratory procedures. Holding times and sample preservation methods will be evaluated to determine whether sample results accurately reflect field conditions. Any deviations from the sampling event plan will be documented in the Quality Control Summary Report (QCSR) along with data qualifications arising from data validation.

Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Sample data should be comparable with other measurement data for similar samples and sample conditions. This goal is achieved through using standard techniques to collect and analyze representative samples and reporting analytical results in standardized units. The data results produced during this project must be comparable to past results.

Completeness

Completeness is the measure of the degree to which the project requirements for sample collection usability, and data quality have been met. For sample collection, completeness is the ratio of the samples actually taken to the number of samples planned to be taken. The method of calculation is given in Section 9.3. The goals for completeness for sample collection for this project is 95%. Modifications made to the proposed sampling scheme by Project Manager will be used to adjust the total number of samples planned for this PA/SI.

Two additional completeness measurements are being used for this project. They are completeness of "usable" (or "acceptable") data and completeness of "quality" data. The "quality" data is defined as data that passed all applicable criteria requiring no qualification during data validation. The "acceptable" data, which includes "quality" data is define as data that may not pass all of the QC criteria but which had appropriate corrective actions taken. Completeness of acceptable data is defined as the ratio of all data that are not rejected to the total number of data points, while completeness of quality data is the ratio of "quality" data to the total number of data points. The goal for usable data is 98%, while the goal for quality data is 80%.

Sensitivity

Sensitivity is based on the minimum detection reported or possible for the analytes. The calculation procedure for the method detection limit (MDL) is given in Section 9.4. The MDL is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero.

3.5 LABORATORY ANALYTICAL PROCEDURES

Analytical parameters for this project include VOCs, TAL metals, and explosives. The surface soil, subsurface soil, sewer sediment, powder well sediment, and groundwater samples will be analyzed at AM Lab for all the required parameters in strict conformance with the published method referenced in Table 6-1.

3.6 ANALYTICAL DETECTION LIMITS

The method detection limit is the minimum concentration of any substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The practical quantitation limit (PQL) is approximately 5 to 10 times the MDL for all analytes. The MDL and practical PQL necessary to meet the sensitivity requirements of this project are shown in Tables 3-1 through 3-13.

3.7 FIELD ANALYTICAL METHODS

3.7.1 Field Instrument Methods

The following list of equipment will be used. The instrument operating specifications are shown in Tables 3-1:

- Air Quality Monitoring – MiniRAE Plus;
- Groundwater Parameter Instrument – YSI 6820 Series Data Sonde;
- Portable Turbidimeter - HF Scientific DRT-15CE.

Table 3-1. Field Instrument Specification

Physical Parameters	Matrix	Units	Range	Instrument	Accuracy	Calibration
pH	Water	pH units	0 to 14 units	YSI 6820 Series Data Sonde	± 0.2 units	Two standard calibration
Temperature	Water	°C	-5 to 45 °C	YSI 6820 Series Data Sonde	± 0.15 °C	NIST thermometer over expected sample temp.
DO	Water	mg/L	0 to 50 mg/L	YSI 6820 Series Data Sonde	0 to 20 mg/L: ± 2.0% of the reading or 0.2 mg/L, whichever is greater 20 to 50 mg/L: ± 6.0% of the reading	Air saturated water
Turbidity	Water	NTU	0 to 1000 NTU	YSI 6820 Series Data Sonde	± 5.0% reading or 2 NTU, whichever is greater	On standards with the expected range
			0 to 10 NTU 0 to 100 NTU 1 to 1000 NTU	DRT-15CE Portable Turbidimeter	± 1.0% reading or 0.02 NTU, whichever is greater	
Conductivity	Water	mS/cm	0 to 100 mS/cm	YSI 6820 Series Data Sonde	± 0.5% reading + 0.001 mS/cm	Two standards with the expected conductance
ORP	Water	mV	-999 to 999 mV	YSI 6820 Series Data Sonde	± 20 mV	One standard within the expected range
PID	Soil	ppm	0 to 999.9 ppm with 0.1 ppm resolution 1000 to 1999 ppm with 1 ppm resolution	MiniRAE Plus	± 0.2 ppm or ±10% of reading calibtated to 100 ppm isobutylene equivalent	Two point field calibration for zero and standard reference gas

Table 3-2. Quality Control Limits for VOCs in Soil/Sediment LCS and LCSD

Analytical Method: SW846/8260B	**Detection & Quantitation Limits**		**LCS Recovery Acceptance Limits**		**LCS/LCSD**
Matrix: Soil	**MDL**	**PQL**	**Lower**	**Upper**	**Dup. Limits**
Compound	**µg/kg**	**µg/kg**	**%R**	**%R**	**%RPD**
Dichlorodifluoromethane	1.55	10	75	125	30
Chloromethane	2.75	10	75	125	30
Vinyl chloride	2.93	10	75	125	30
Bromomethane	1.92	10	75	125	30
Chloroethane	1.85	10	75	125	30
1,1-Dichloroethene	1.03	10	75	125	30
Acetone	5.26	20	60	140	40
Methylene chloride	5.16	20	60	140	40
Trans-1,2-Dichloroethene	0.60	10	75	125	30
Methyl-tert-butyl ether (MTBE)	0.81	10	75	125	30
1,1- Dichloroethane	2.34	10	75	125	30
Cis-1,2-Dichloroethene	0.76	10	75	120	30
2,2-Dichloropropane	1.63	10	75	125	30
Bromochloromethane	1.01	10	75	125	30
Chloroform	0.93	10	75	125	30
1,1,1-Trichloroethane	0.57	10	75	125	30
1,1-Dichloropropene	0.83	10	75	125	30
Carbon Tetrachloride	0.26	10	75	125	30
1,2-Dichloroethane	1.32	10	75	125	30
Benzene	0.97	10	75	125	30
Trichloroethene	0.72	10	75	125	30
1,2-Dichloropropane	1.72	10	75	125	30
Dibromomethane	1.54	10	75	125	30
Bromodichloromethane	1.07	10	75	125	30
Cis-1,3-Dichloropropene	0.56	10	75	125	30
4-Methyl-2-pentanone	2.53	10	75	125	30
Toluene	1.02	10	75	125	30
Trans-1,3-Dichloropropene	1.06	10	75	125	30
1,1,2-Trichloroethane	1.61	10	75	125	30
1,3-Dichloropropane	1.17	10	75	125	30
Tetrachloroethene	1.21	10	75	125	30
2-Hexanone	2.06	10	75	125	30
Dibromochloromethane	0.89	10	75	125	30
1,2-Dibromoethane	0.82	10	75	125	30
Chlorobenzene	0.91	10	75	125	30
1,1,1,2-Tetrachloroethane	0.55	10	75	125	30
Ethylbenzene	0.62	10	75	125	30

Table 3-2. Quality Control Limits for VOCs in Soil/Sediment LCS and LCSD (cont.)

Analytical Method: SW846/8260B	Detection & Quantitation Limits		LCS Recovery Acceptance Limits		LCS/LCSD
Matrix: Soil	**MDL**	**PQL**	**Lower**	**Upper**	**Dup. Limits**
Compound	**µg/kg**	**µg/kg**	**%R**	**%R**	**%RPD**
Meta/para-Xylene	2.68	10	75	125	30
Ortho-Xylene	0.89	10	75	125	30
Styrene	0.70	10	60	140	40
Bromoform	0.49	10	75	125	30
Isopropylbenzene	0.49	10	75	125	30
1,1,2,2-Tetrachloroethane	1.24	10	75	125	50
1,2,3-Trichloropropane	0.93	10	75	125	30
Bromobenzene	1.00	10	75	125	30
N-Propylbenzene	0.60	10	75	125	30
2-Chlorotoluene	0.75	10	75	125	30
1,3,5-Trimethyl benzene	0.86	10	60	140	40
4-Chlorotoluene	1.70	10	75	125	30
Tert-butyl benzene	1.81	10	75	125	30
1,2,4-Trimethylbenzene	1.01	10	60	140	40
Sec-butyl benzene	2.11	10	75	125	30
1,3-Dichlorobenzene	0.66	10	75	125	30
Para-isopropyltoluene	0.95	10	75	125	30
1,4-Dichlorobenzene	0.67	10	75	125	30
N-butylbenzene	0.78	10	75	125	30
1,2-Dichlorobenzene	0.90	10	75	125	30
1,2,4-Trichlorobenzene	1.17	10	75	125	30
Hexachlorobutadiene	0.72	10	75	125	30
Naphthalene	1.49	10	75	125	30
1,2,3-Trichlorobenzene	0.90	10	75	125	30

Surrogates*:

4-Bromofluorobenzene*	1	10	74	121	
Dibromofluoromethane	1	10	80	120	
Toluene-d8	1	10	81	117	
Dichloroethane-d4	1	10	80	120	

* These EPA limits are slightly different from the USACE guidance limits (75-125%)

Table 3-3. Quality Control Limits for VOCs in Soil/Sediment MS and MSD

Analytical Method: SW846/8260B	**Detection & Quantitation Limits**		**LCS Recovery Acceptance Limits**		**LCS/LCSD**
Matrix: Soil	**MDL**	**PQL**	**Lower**	**Upper**	**Dup. Limits**
Compound	**µg/kg**	**µg/kg**	**%R**	**%R**	**%RPD**
Dichlorodifluoromethane	1.55	10	70	130	40
Chloromethane	2.75	10	70	130	40
Vinyl chloride	2.93	10	70	130	40
Bromomethane	1.92	10	70	130	40
Chloroethane	1.85	10	70	130	40
1,1-Dichloroethene	1.03	10	70	130	40
Acetone	5.26	20	60	140	40
Methylene chloride	5.16	20	60	140	40
Trans-1,2-Dichloroethene	0.60	10	70	130	40
Methyl-tert-butyl ether (MTBE)	0.81	10	70	130	40
1,1- Dichloroethane	2.34	10	70	130	40
Cis-1,2-Dichloroethene	0.76	10	70	120	40
2,2-Dichloropropane	1.63	10	70	130	40
Bromochloromethane	1.01	10	70	130	40
Chloroform	0.93	10	70	130	40
1,1,1-Trichloroethane	0.57	10	70	130	40
1,1-Dichloropropene	0.83	10	70	130	40
Carbon Tetrachloride	0.26	10	70	130	40
1,2-Dichloroethane	1.32	10	70	130	40
Benzene	0.97	10	70	130	40
Trichloroethene	0.72	10	70	130	40
1,2-Dichloropropane	1.72	10	70	130	40
Dibromomethane	1.54	10	70	130	40
Bromodichloromethane	1.07	10	70	130	40
Cis-1,3-Dichloropropene	0.56	10	70	130	40
4-Methyl-2-pentanone	2.53	10	70	130	40
Toluene	1.02	10	70	130	40
Trans-1,3-Dichloropropene	1.06	10	70	130	40
1,1,2-Trichloroethane	1.61	10	70	130	40
1,3-Dichloropropane	1.17	10	70	130	40
Tetrachloroethene	1.21	10	70	130	40
2-Hexanone	2.06	10	70	130	40
Dibromochloromethane	0.89	10	70	130	40
1,2-Dibromoethane	0.82	10	70	130	40
Chlorobenzene	0.91	10	70	130	40
1,1,1,2-Tetrachloroethane	0.55	10	70	130	40
Ethylbenzene	0.62	10	70	130	40

Table 3-3. Quality Control Limits for VOCs in Soil/Sediment MS and MSD (cont.)

Analytical Method: SW846/8260B	Detection & Quantitation Limits		LCS Recovery Acceptance Limits		LCS/LCSD
Matrix: Soil	**MDL**	**PQL**	**Lower**	**Upper**	**Dup. Limits**
Compound	**µg/kg**	**µg/kg**	**%R**	**%R**	**%RPD**
Meta/para-Xylene	2.68	10	70	130	40
Ortho-Xylene	0.89	10	70	130	40
Styrene	0.70	10	60	140	40
Bromoform	0.49	10	70	130	40
Isopropylbenzene	0.49	10	70	130	40
1,1,2,2-Tetrachloroethane	1.24	10	70	130	50
1,2,3-Trichloropropane	0.93	10	70	130	40
Bromobenzene	1.00	10	70	130	40
N-Propylbenzene	0.60	10	70	130	40
2-Chlorotoluene	0.75	10	70	130	40
1,3,5-Trimethyl benzene	0.86	10	60	140	40
4-Chlorotoluene	1.70	10	70	130	40
Tert-butyl benzene	1.81	10	70	130	40
1,2,4-Trimethylbenzene	1.01	10	60	140	40
Sec-butyl benzene	2.11	10	70	130	40
1,3-Dichlorobenzene	0.66	10	70	130	40
Para-isopropyltoluene	0.95	10	70	130	40
1,4-Dichlorobenzene	0.67	10	70	130	40
N-butylbenzene	0.78	10	70	130	40
1,2-Dichlorobenzene	0.90	10	70	130	40
1,2,4-Trichlorobenzene	1.17	10	70	130	40
Hexachlorobutadiene	0.72	10	70	130	40
Naphthalene	1.49	10	70	130	40
1,2,3-Trichlorobenzene	0.90	10	70	130	40

Surrogates*:

4-Bromofluorobenzene*	1	10	74	121	
Dibromofluoromethane	1	10	80	120	
Toluene-d8	1	10	81	117	
Dichloroethane-d4	1	10	80	120	

* These EPA limits are slightly different from the USACE guidance limits (75-125%)

Table 3-4. Quality Control Limits for VOCs in Groundwater LCS and LCSD

Analytical Method: SW846/8260B	**Detection & Quantitation Limits**		**LCS Recovery Acceptance Limits**		**LCS/LCSD Duplicates**
Matrix: Groundwater (25-mL purge)	**MDL**	**PQL**	**Lower**	**Upper**	**Dup. Limits**
Compound	**µg/L**	**µg/L**	**%R**	**%R**	**%RPD**
Dichlorodofluoromethane	0.45	2	80	120	30
Chloromethane	0.17	2	80	120	30
Vinyl Chloride	0.24	2	80	120	30
Bromomethane	0.20	2	80	120	30
Chloroethane	0.21	2	80	120	30
1,1-Dichloroethene	0.18	2	80	120	30
Acetone	0.62	5	60	140	40
Methylene Chloride	0.40	5	60	140	40
Trans-1,2-Dichloroethene	0.15	2	80	120	30
Methyl-t-butyl ether (MTBE)	0.09	2	80	120	30
1,1-Dichloroethane	0.21	2	80	120	30
2-Butanone	0.48	5	80	120	30
Cis-1,2-Dichloroethene	0.15	2	80	120	30
2,2-Dichloropropane	0.11	2	80	120	30
Bromochloromethane	0.17	2	80	120	30
Chloroform	0.21	2	80	120	30
1,1,1-Trichloroethane	0.18	2	80	120	30
1,1-Dichloropropene	0.07	2	80	120	30
Carbon Tetrachloride	0.14	2	80	120	30
1,2-Dichloroethane	0.18	2	80	120	30
Benzene	0.14	2	80	120	30
Trichloroethene	0.15	2	80	120	30
1,2,-Dichloropropane	0.12	2	80	120	30
Dibromomethane	0.10	2	80	120	30
Bromodichloromethane	0.14	2	80	120	30
Cis-1,3-Dichloropropene	0.06	2	80	120	30
4-Methyl-2-pentanone	0.13	2	80	120	30
Toluene	0.11	2	80	120	30
Trans-1,3-Dichloropropene	0.08	2	80	120	30
1,1,2-Trichloroethane	0.14	2	80	120	30
1,3-Dichloropropane	0.11	2	80	120	30
Tetrachloroethene	0.12	2	80	120	30
2-Hexanone	0.16	2	80	120	30
Dibromochloromethane	0.13	2	80	120	30
1,2-Dibromoethane	0.12	2	80	120	30
Chlorobenzene	0.16	2	80	120	30
1,1,1,2-Tetrachloroethane	0.22	2	80	120	30
Ethylbenzene	0.10	2	80	120	30

Table 3-4. Quality Control Limits for VOCs in Groundwater LCS and LCSD (cont.)

Analytical Method: SW846/8260B	**Detection & Quantitation Limits**		**LCS Recovery Acceptance Limits**		**LCS/LCSD Duplicates**
Matrix: Groundwater (25-mL purge)	**MDL**	**PQL**	**Lower**	**Upper**	**Dup. Limits**
Compound	**µg/L**	**µg/L**	**%R**	**%R**	**%RPD**
M/P-Xylene	0.22	2	80	120	30
O-Xylene	0.10	2	80	120	30
Styrene	0.07	2	60	140	40
Bromoform	0.16	2	80	120	30
Isopropylbenzene	0.08	2	80	120	30
1,1,2,2-Tetrachloroethane	0.06	2	80	120	30
1,2,3-Trichloropropane	0.34	2	80	120	30
Bromobenzene	0.36	2	80	120	30
N-Propylbenzene	0.06	2	80	120	30
2-Chlorotoluene	0.11	2	80	120	30
1,3,5-Trimethyl Benzene	0.11	2	60	140	40
4-Chlorotoluene	0.09	2	80	120	30
Tert-butyl Benzene	0.07	2	80	120	30
1,2,4-Trimethylbenzene	0.11	2	60	140	40
Sec-butyl Benzene	0.13	2	80	120	30
1,3-Dichlorobenzene	0.19	2	80	120	30
P-isopropyltoluene	0.07	2	80	120	30
1,4-Dichlorobenzene	0.15	2	80	120	30
N-Butylbenzene	0.07	2	80	120	30
1,2-Dichlorobenzene	0.14	2	80	120	30
1,2,4-Trichlorobenzene	0.11	2	80	120	30
Hexachlorobutadiene	0.19	3	80	120	30
Naphthalene	0.14	2	80	120	30
1,2,3-Trichlorobenzene	0.14	2	80	120	30

Surrogates*:

4-Bromofluorobenzene	0.4	2	86	115	
Dibromofluoromethane	0.4	2	86	118	
Toluene-d8	0.4	2	88	110	
Dichloroethane-d4	0.4	2	80	120	

* These EPA limits are slightly different from the USACE guidance limits (80-120%)

Table 3-5. Quality Control Limits for VOCs in Groundwater MS and MSD

Analytical Method: SW846/8260B	Detection & Quantitation Limits		LCS Recovery Acceptance Limits		LCS/LCSD Duplicates
Matrix: Groundwater (25-mL purge)	**MDL**	**PQL**	**Lower**	**Upper**	**Dup. Limits**
Compound	**µg/L**	**µg/L**	**%R**	**%R**	**%RPD**
Dichlorodofluoromethane	0.45	2	70	130	40
Chloromethane	0.17	2	70	130	40
Vinyl Chloride	0.24	2	70	130	40
Bromomethane	0.20	2	70	130	40
Chloroethane	0.21	2	70	130	40
1,1-Dichloroethene	0.18	2	70	130	40
Acetone	0.62	5	60	140	40
Methylene Chloride	0.40	5	60	140	40
Trans-1,2-Dichloroethene	0.15	2	70	130	40
Methyl-t-butyl ether (MTBE)	0.09	2	70	130	40
1,1-Dichloroethane	0.21	2	70	130	40
2-Butanone	0.48	5	70	130	40
Cis-1,2-Dichloroethene	0.15	2	70	130	40
2,2-Dichloropropane	0.11	2	70	130	40
Bromochloromethane	0.17	2	70	130	40
Chloroform	0.21	2	70	130	40
1,1,1-Trichloroethane	0.18	2	70	130	40
1,1-Dichloropropene	0.07	2	70	130	40
Carbon Tetrachloride	0.14	2	70	130	40
1,2-Dichloroethane	0.18	2	70	130	40
Benzene	0.14	2	70	130	40
Trichloroethene	0.15	2	70	130	40
1,2,-Dichloropropane	0.12	2	70	130	40
Dibromomethane	0.10	2	70	130	40
Bromodichloromethane	0.14	2	70	130	40
Cis-1,3-Dichloropropene	0.06	2	70	130	40
4-Methyl-2-pentanone	0.13	2	70	130	40
Toluene	0.11	2	70	130	40
Trans-1,3-Dichloropropene	0.08	2	70	130	40
1,1,2-Trichloroethane	0.14	2	70	130	40
1,3-Dichloropropane	0.11	2	70	130	40
Tetrachloroethene	0.12	2	70	130	40
2-Hexanone	0.16	2	70	130	40
Dibromochloromethane	0.13	2	70	130	40
1,2-Dibromoethane	0.12	2	70	130	40
Chlorobenzene	0.16	2	70	130	40
1,1,1,2-Tetrachloroethane	0.22	2	70	130	40
Ethylbenzene	0.10	2	70	130	40

Table 3-5. Quality Control Limits for VOCs in Groundwater MS and MSD (cont.)

Analytical Method: SW846/8260B	**Detection & Quantitation Limits**		**LCS Recovery Acceptance Limits**		**LCS/LCSD Duplicates**
Matrix: Groundwater (25-mL purge)	**MDL**	**PQL**	**Lower**	**Upper**	**Dup. Limits**
Compound	**μg/L**	**μg/L**	**%R**	**%R**	**%RPD**
M/P-Xylene	0.22	2	70	130	40
O-Xylene	0.10	2	70	130	40
Styrene	0.07	2	60	140	40
Bromoform	0.16	2	70	130	40
Isopropylbenzene	0.08	2	70	130	40
1,1,2,2-Tetrachloroethane	0.06	2	70	130	40
1,2,3-Trichloropropane	0.34	2	70	130	40
Bromobenzene	0.36	2	70	130	40
N-Propylbenzene	0.06	2	70	130	40
2-Chlorotoluene	0.11	2	70	130	40
1,3,5-Trimethyl Benzene	0.11	2	60	140	40
4-Chlorotoluene	0.09	2	70	130	40
Tert-butyl Benzene	0.07	2	70	130	40
1,2,4-Trimethylbenzene	0.11	2	60	140	40
Sec-butyl Benzene	0.13	2	70	130	40
1,3-Dichlorobenzene	0.19	2	70	130	40
P-isopropyltoluene	0.07	2	70	130	40
1,4-Dichlorobenzene	0.15	2	70	130	40
N-Butylbenzene	0.07	2	70	130	40
1,2-Dichlorobenzene	0.14	2	70	130	40
1,2,4-Trichlorobenzene	0.11	2	70	130	40
Hexachlorobutadiene	0.19	3	70	130	40
Naphthalene	0.14	2	70	130	40
1,2,3-Trichlorobenzene	0.14	2	70	130	40

Surrogates*:

4-Bromofluorobenzene	0.4	2	86	115	
Dibromofluoromethane	0.4	2	86	118	
Toluene-d8	0.4	2	88	110	
Dichloroethane-d4	0.4	2	80	120	

* These EPA limits are slightly different from the USACE guidance limits (80-120%)

Table 3-6. Quality Control Limits for Explosive Residues in Soil/Sediment LCS and LCSD

Test: Nitroaromatics & Nitramines by HPLC	**Reporting and Quantitation Limits**		**Acceptance Limits**		
Matrix: Soil/Sediment			**LCS Recoveries**		**LCS/LCSD**
Method: SW846/8330B	**RL**	**PQL**	**Lower**	**Upper**	**Dup. Limits**
Compound	**mg/kg**	**mg/kg**	**%R**	**%R**	**%RPD**
HMX	0.3	1.0	70	130	30
RDX	0.1	0.6	70	130	30
1,3,5-Trinitrobenzene	0.1	0.6	70	130	30
1,3-Dinitrobenzene	0.1	0.6	70	130	30
Tetryl	0.1	0.6	40	150	60
Nitrobenzene	0.1	0.6	70	130	30
2,4,6-Trinitrotoluene	0.1	0.6	70	130	30
4-Amino-2,6-dinitrotoluene	0.1	0.6	70	130	30
2-Amino-4,6-dinitrotoluene	0.1	0.6	70	130	30
2,4-Dinitrotoluene	0.1	0.6	70	130	30
2,6-Dinitrotoluene	0.1	0.6	70	130	30
2-Nitrotoluene	0.1	0.6	70	130	30
3-Nitrotoluene	0.1	0.6	70	130	30
4-Nitrotoluene	0.1	0.6	70	130	30

Surrogates:

1-Chloro-3-nitrobenzene	0.1	0.6	70	130	30

%Recovery limits for sporadic marginal failure: ±50% from true value.
RPD limits for sporadic marginal failure: 60%

Table 3-7. Quality Control Limits for Explosive Residues in Soil/Sediment MS and MSD

Test: Nitroaromatics & Nitramines by HPLC	**Reporting and Quantitation Limits**		**Acceptance Limits**		
Matrix: Soil/Sediment			**MS Recoveries**		**MS/MSD**
Method: SW846/8330B	**RL**	**PQL**	**Lower**	**Upper**	**Dup. Limits**
Compound	**mg/kg**	**mg/kg**	**%R**	**%R**	**%RPD**
HMX	0.3	1.0	50	150	50
RDX	0.1	0.6	50	150	50
1,3,5-Trinitrobenzene	0.1	0.6	50	150	50
1,3-Dinitrobenzene	0.1	0.6	50	150	50
Tetryl	0.1	0.6	40	150	60
Nitrobenzene	0.1	0.6	50	150	50
2,4,6-Trinitrotoluene	0.1	0.6	50	150	50
4-Amino-2,6-dinitrotoluene	0.1	0.6	50	150	50
2-Amino-4,6-dinitrotoluene	0.1	0.6	50	150	50
2,4-Dinitrotoluene	0.1	0.6	50	150	50
2,6-Dinitrotoluene	0.1	0.6	50	150	50
2-Nitrotoluene	0.1	0.6	50	150	50
3-Nitrotoluene	0.1	0.6	50	150	50
4-Nitrotoluene	0.1	0.6	50	150	50

Surrogates:

1-Chloro-3-nitrobenzene	0.1	0.6	50	150	50

%Recovery limits for sporadic marginal failure: ±50% from true value.
RPD limits for sporadic marginal failure: 60%

Table 3-8. Quality Control Limits for Explosive Residues in Groundwater LCS and LCSD

Test: Nitroaromatics & Nitramines by HPLC	**Reporting & Quantitation Limits**		**Acceptance Limits**		**Acceptance Limits**
Matrix: Groundwater			**LCS Recoveries**		**LCS/LCSD**
Method: SW846/8330B	**RL**	**PQL**	**Lower**	**Upper**	**Dup. Limits**
Compound	**µg/L**	**µg/L**	**%R**	**%R**	**%RPD**
HMX	0.3	1.0	70	130	30
RDX	0.1	0.6	70	130	30
1,3,5-Trinitrobenzene	0.1	0.6	70	130	30
1,3-Dinitrobenzene	0.1	0.6	70	130	30
Tetryl	0.1	0.6	40	150	60
Nitrobenzene	0.1	0.6	70	130	30
2,4,6-Trinitrotoluene	0.1	0.6	70	130	30
4-Amino-2,6-dinitrotoluene	0.1	0.6	70	130	30
2-Amino-4,6-dinitrotoluene	0.1	0.6	70	130	30
2,4-Dinitrotoluene	0.1	0.6	70	130	30
2,6-Dinitrotoluene	0.1	0.6	70	130	30
2-Nitrotoluene	0.1	0.6	70	130	30
3-Nitrotoluene	0.1	0.6	70	130	30
4-Nitrotoluene	0.1	0.6	70	130	30

Surrogates:

1-Chloro-3-nitrobenzene	0.1	0.6	60	140	40

%Recovery limits for sporadic marginal failure: ±50% from true value.
RPD limits for sporadic marginal failure: 60%

Table 3-9. Quality Control Limits for Explosive Residues in Groundwater MS and MSD

Test: Nitroaromatics & Nitramines by HPLC	**Reporting & Quantitation Limits**		**MS and LCS Recovery**		**MS/MSD &**
Matrix: Groundwater			**Acceptance Limits**		**LCS/LCSD**
Method: SW846/8330B	**RL**	**PQL**	**Lower**	**Upper**	**Dup. Limits**
Compound	**µg/L**	**µg/L**	**%R**	**%R**	**%RPD**
HMX	0.3	1.0	50	140	50
RDX	0.1	0.6	50	140	50
1,3,5-Trinitrobenzene	0.1	0.6	50	140	50
1,3-Dinitrobenzene	0.1	0.6	50	140	50
Tetryl	0.1	0.6	50	140	60
Nitrobenzene	0.1	0.6	50	140	50
2,4,6-Trinitrotoluene	0.1	0.6	50	140	50
4-Amino-2,6-dinitrotoluene	0.1	0.6	50	140	50
2-Amino-4,6-dinitrotoluene	0.1	0.6	50	140	50
2,4-Dinitrotoluene	0.1	0.6	50	140	50
2,6-Dinitrotoluene	0.1	0.6	50	140	50
2-Nitrotoluene	0.1	0.6	50	140	50
3-Nitrotoluene	0.1	0.6	50	140	50
4-Nitrotoluene	0.1	0.6	50	140	50

Surrogates:

1-Chloro-3-nitrobenzene	0.1	0.6	50	150	50

%Recovery limits for sporadic marginal failure: ±50% from true value.
RPD limits for sporadic marginal failure: 60%

Table 3-10. Quality Control Limits for Metals in Soil/Sediment LCS and LCSD

Test: Metals		**Reporting & Quantitation Limits**		**Acceptance Limits For Percent Recoveries**		**Acceptance Limit for Duplicates**
Matrix: Soil/Sediment				**LCS and LCSD**		**LCS/LCSD**
Element	**EPA Method Numbers**	**RL mg/kg**	**PQL mg/kg**	**Lower %R**	**Upper %R**	**Limit %RPD**
ICP-AES*:						
Aluminum	200.7/6010B	4.0	8.0	80	120	25
Antimony	200.7/6010B	1.6	2.4	80	120	25
Arsenic	200.7/6010B	2.8	5.6	80	120	25
Barium	200.7/6010B	0.2	8.0	80	120	25
Beryllium	200.7/6010B	0.04	0.2	80	120	25
Cadmium	200.7/6010B	0.24	0.2	80	120	25
Calcium	200.7/6010B	4.0	200	80	120	25
Chromium	200.7/6010B	0.4	0.4	80	120	25
Cobalt	200.7/6010B	0.4	2.0	80	120	25
Copper	200.7/6010B	0.4	1.0	80	120	25
Iron	200.7/6010B	4.0	4.0	80	120	25
Lead	200.7/6010B	2.0	4.0	80	120	25
Magnesium	200.7/6010B	4.0	200	80	120	25
Manganese	200.7/6010B	0.2	0.6	80	120	25
Nickel	200.7/6010B	0.6	1.6	80	120	25
Potassium	200.7/6010B	100	200	80	120	25
Selenium	200.7/6010B	2.4	4.8	80	120	25
Silver	200.7/6010B	0.6	0.4	80	120	25
Sodium	200.7/6010B	8.0	200	80	120	25
Thallium	200.7/6010B	1.4	2.8	80	120	25
Vanadium	200.7/6010B	0.28	2.0	80	120	25
Zinc	200.7/6010B	0.2	0.8	80	120	25
GFAA and CVAA:						
Arsenic	206.2/7060A	0.12	0.4	80	120	20
Lead	239.2/7421	0.12	0.4	80	120	20
Mercury	245.1/7471A	0.042	0.083	80	120	20
Selenium	270.2/7740	0.08	0.4	80	120	20
Thallium	279.2/7841	0.16	0.4	80	120	20

* Percent recovery limits for sporadic marginal failure: 60% to 140%.

Table 3-11. Quality Control Limits for Metals in Soil/Sediment MS and MSD

Test: Metals		Reporting & Quantitation Limits		Acceptance Limits For Percent Recoveries		Acceptance Limit for Duplicates
Matrix: Soil/Sediment				**MS and MSD**		**MS/MSD**
Element	**EPA Method Numbers**	**RL mg/kg**	**PQL mg/kg**	**Lower %R**	**Upper %R**	**Limit %RPD**
ICP-AES*:						
Aluminum	200.7/6010B	4.0	8.0	75	125	25
Antimony	200.7/6010B	1.6	2.4	75	125	25
Arsenic	200.7/6010B	2.8	5.6	75	125	25
Barium	200.7/6010B	0.2	8.0	75	125	25
Beryllium	200.7/6010B	0.04	0.2	75	125	25
Cadmium	200.7/6010B	0.24	0.2	75	125	25
Calcium	200.7/6010B	4.0	200	75	125	25
Chromium	200.7/6010B	0.4	0.4	75	125	25
Cobalt	200.7/6010B	0.4	2.0	75	125	25
Copper	200.7/6010B	0.4	1.0	75	125	25
Iron	200.7/6010B	4.0	4.0	75	125	25
Lead	200.7/6010B	2.0	4.0	75	125	25
Magnesium	200.7/6010B	4.0	200	75	125	25
Manganese	200.7/6010B	0.2	0.6	75	125	25
Nickel	200.7/6010B	0.6	1.6	75	125	25
Potassium	200.7/6010B	100	200	75	125	25
Selenium	200.7/6010B	2.4	4.8	75	125	25
Silver	200.7/6010B	0.6	0.4	75	125	25
Sodium	200.7/6010B	8.0	200	75	125	25
Thallium	200.7/6010B	1.4	2.8	75	125	25
Vanadium	200.7/6010B	0.28	2.0	75	125	25
Zinc	200.7/6010B	0.2	0.8	75	125	25
GFAA and CVAA:						
Arsenic	206.2/7060A	0.12	0.4	80	120	20
Lead	239.2/7421	0.12	0.4	80	120	20
Mercury	245.1/7471A	0.042	0.083	80	120	20
Selenium	270.2/7740	0.08	0.4	80	120	20
Thallium	279.2/7841	0.16	0.4	80	120	20

* Percent recovery limits for sporadic marginal failure: 60% to 140%.

Table 3-12. Quality Control Limits for Metals in Groundwater LCS and LCSD

Test: Metals		**Reporting & Quantitation Limits**		**Acceptance Limits For Percent Recoveries**		**Acceptance Limit for Duplicates**
Matrix: Groundwater				**LCS and LCSD**		**LCS/LCSD**
Element	**EPA Method Numbers**	**RL µg/L**	**PQL µg/L**	**Lower %R**	**Upper %R**	**Dup. Limits %RPD**
ICP-AES*:						
Aluminum	200.7/6010B	100	400	80	120	25
Antimony	200.7/6010B	40	120	80	120	25
Arsenic	200.7/6010B	70	200	80	120	25
Barium	200.7/6010B	5	400	80	120	25
Beryllium	200.7/6010B	1	10	80	120	25
Cadmium	200.7/6010B	6	10	80	120	25
Calcium	200.7/6010B	100	10000	80	120	25
Chromium	200.7/6010B	10	20	80	120	25
Cobalt	200.7/6010B	10	100	80	120	25
Copper	200.7/6010B	10	50	80	120	25
Iron	200.7/6010B	10	20	80	120	25
Lead	200.7/6010B	5	20	80	120	25
Magnesium	200.7/6010B	10	10000	80	120	25
Manganese	200.7/6010B	5	30	80	120	25
Nickel	200.7/6010B	15	80	80	120	25
Potassium	200.7/6010B	2500	10000	80	120	25
Selenium	200.7/6010B	60	200	80	120	25
Silver	200.7/6010B	15	20	80	120	25
Sodium	200.7/6010B	200	10000	80	120	25
Thallium	200.7/6010B	35	200	80	120	25
Vanadium	200.7/6010B	7	100	80	120	25
Zinc	200.7/6010B	5	40	80	120	25
GFAA and CVAA:						
Arsenic	206.2/7060A	3	10	80	120	20
Lead	239.2/7421	2	10	80	120	20
Mercury	245.1/7470A	0.25	0.5	80	120	20
Selenium	270.2/7740	1	10	80	120	20
Thallium	279.2/7841	2	10	80	120	20

* Percent recovery limits for sporadic marginal failure: 60% to 140%.

Table 3-13. Quality Control Limits for Metals in Groundwater MS and MSD

Test: Metals		**Reporting & Quantitation Limits**		**Acceptance Limits For Percent Recoveries**		**Acceptance Limit for Duplicates**
Matrix: Groundwater				**MS and MSD**		**MS/MSD**
Element	**EPA Method Numbers**	**RL µg/L**	**PQL µg/L**	**Lower %R**	**Upper %R**	**Dup. Limits %RPD**
ICP-AES*:						
Aluminum	200.7/6010B	100	400	75	125	25
Antimony	200.7/6010B	40	120	75	125	25
Arsenic	200.7/6010B	70	200	75	125	25
Barium	200.7/6010B	5	400	75	125	25
Beryllium	200.7/6010B	1	10	75	125	25
Cadmium	200.7/6010B	6	10	75	125	25
Calcium	200.7/6010B	100	10000	75	125	25
Chromium	200.7/6010B	10	20	75	125	25
Cobalt	200.7/6010B	10	100	75	125	25
Copper	200.7/6010B	10	50	75	125	25
Iron	200.7/6010B	10	20	75	125	25
Lead	200.7/6010B	5	20	75	125	25
Magnesium	200.7/6010B	10	10000	75	125	25
Manganese	200.7/6010B	5	30	75	125	25
Nickel	200.7/6010B	15	80	75	125	25
Potassium	200.7/6010B	2500	10000	75	125	25
Selenium	200.7/6010B	60	200	75	125	25
Silver	200.7/6010B	15	20	75	125	25
Sodium	200.7/6010B	200	10000	75	125	25
Thallium	200.7/6010B	35	200	75	125	25
Vanadium	200.7/6010B	7	100	75	125	25
Zinc	200.7/6010B	5	40	75	125	25
GFAA and CVAA:						
Arsenic	206.2/7060A	3	10	80	120	20
Lead	239.2/7421	2	10	80	120	20
Mercury	245.1/7470A	0.25	0.5	80	120	20
Selenium	270.2/7740	1	10	80	120	20
Thallium	279.2/7841	2	10	80	120	20

* Percent recovery limits for sporadic marginal failure: 60% to 140%.

4.0 SAMPLING LOCATIONS AND PROCEDURES

Sampling locations and rationale for sample collection are presented in Section 4.0 of the FSP.

5.0 SAMPLE CUSTODY AND HOLDING TIMES

Sample custody prior to shipping will be maintained using the procedures described in Section 5.0 of the FSP.

Upon receipt at the laboratory, the sample custodian will inspect samples to verify the condition of samples and sample containers and will fill out a cooler receipt form (Figure 5-1). The sample custodian will check the temperature of the water in the temperature blank container enclosed in the cooler. Samples received at the laboratory are removed from the shipping cooler and the sample bottle label is compared to the information written on the COC forms. If discrepancy exists, appropriate notes (signed and dated) will be made on the COC form and the laboratory manager will be notified.

The following items will be checked upon receipt of samples with the COC document:

- The seals and tapes on the sample containers and the cooler are unbroken and uncut;
- The sample containers in the cooler are intact and inside temperature of the cooler is recorded;
- The identification on the sample bottles corresponds to the entries on the accompanying COC forms;
- The number of sample containers received (i.e., bottles) is equal to the number of sample containers listed on the COC forms.

Laboratory identification numbers are labeled on the containers and are then securely wrapped. Samples are not planned for inter-laboratory shipping. Therefore, inter-laboratory COC procedures and sample packaging for subsequent laboratory shipping are not discussed here.

Holding times and preservatives for the samples are shown in Table 5-1. If holding times are not met on any analysis, the laboratory will proceed with corrective actions as discussed in Section 10.2 and document their implementation.

Figure 5-1. Cooler Receipt Form

PA/SI at the Former St. Louis Ordnance Plant, St. Louis County, Missouri

LIMS No.: ________________ Contractor Cooler: ________________
QA Lab Cooler No.: ________________
Number of Coolers: ________________

PROJECT: ________________________________ Date Received: ____________

USE OTHER SIDE OF THIS FORM TO NOTE DETAILS CONCERNING CHECK-IN PROBLEMS

A. **PRELIMINARY EXAMINATION PHASE**: Date Cooler was opened: ________________

By (print) ________________ (sign) ________________________

1. Did cooler come with a shipping slip (are bill, etc.)?............YES NO
   If YES, enter carrier name and air bill number here: ________________________
2. Were custody seals on outside of cooler?............YES NO

   How many and where: ________________ , seal date: ____________ , seal name: ________
3. Were custody seals unbroken and intact at the date and time of arrival?............YES NO
4. Were custody papers seals in a plastic bag and taped inside to the lid?............YES NO
5. Were custody papers filled out properly (ink, signed, etc.)?............YES NO
6. Did you sign custody papers in the appropriate place?............YES NO
7. Was project identifiable from custody papers? If YES, enter project name at the top of this form?............YES NO
8. If required, was enough double bagged ice used?............YES NO

   Cooler temperature? ________________ Type of ice: ________________
9. Have designated person initial here to acknowledge receipt of cooler: ____________ Date: ________

B. **LOG-IN PHASE**: Date samples were logged-in: ________________________

By (print) ________________ (sign) ________________________

10. Describe type of packing in cooler: ________________________________
11. Were all bottles sealed in separate plastic bags?............YES NO
12. Did all bottles arrive unbroken and were labels in good condition?............YES NO
13. Were all bottle labels complete (ID, date, time, signature, preservative, etc.)?............YES NO
14. Did all bottle labels agree with custody papers?............YES NO
15. Were correct containers used for the tests indicated?............YES NO
16. Were correct preservatives added to samples?............YES NO
17. Was a sufficient amount of sample sent for tests indicated?............YES NO
18. Were bubbles absent in VOA samples? If NO, list by CAS: ________________ YES NO
19. Was the project manager called and status discussed? If YES, give details on the back of this form............YES NO
20. Who was called? ________________ By whom? ________________ Date: ____________

Table 5-1. Summary of Sample Container Specifications, Preservatives, Sample Volumes, and Holding Times

Analyte	Minimum Sample Volume	Container	Preservative	Holding Time (VTS)[1]
Groundwater/Surface water:				
VOCs	40 mL	3-40 mL glass vial	HCl, pH < 2 Cool 4 ± 2°C	14 days
TAL Metals	100 mL	1000 mL HDPE	HNO_3, pH<2 Cool 4 ± 2°C	6 months (except. Hg) 28 days (Hg)
Explosive Residues	1000 mL	1000 mL dark amber glass	Cool 4 ± 2°C	7 days to extract 30 days to analyze
Soil/Sediment:				
VOCs	5 mg plugs 3 X 40 ml	EasyDraw Syringe™	Cool 4 +/- 2°C Sodium Bisulfate	48 hours
TAL Metals	5 grams (exc.Hg) 1 gram (Hg)	4 oz. Wide-mouth clear jar	Cool 4 +/- 2°C	6 months (except Hg) 28 days (Hg)
Explosives Residues	5 grams	4 oz. Wide-mouth clear jar	Cool 4 +/- 2°C	14 days to extract 40 days to analyze
Subsurface Soil:				
VOCs	5 mg plugs 3 X 40 ml	EasyDraw Syringe™	Cool 4 +/- 2°C Sodium Bisulfate	48 hours

Notes:

Additional sample volume is required for matrix quality control.
[1]VTS - Verified Time of Sampling

6.0 ANALYTICAL PROCEDURES

6.1 ANALYTICAL PROCEDURES, SAMPLES, AND METHODS

Table 6-1 shows a summary of number of primary and QC samples that will be collected and the analytical methods that will be used for analysis for SLOP samples. The subcontract laboratory is certified by the USACE to conduct the designated analysis. Subcontract laboratory SOPs are provided in the Laboratory Quality Assurance Project Plan (LQAPP) for all analyses to be performed. The LQAPP is available at TapanAm office for review. The associated QC limits for each matrix and analyte are described in Section 3.0.

Table 6-1. Summary of Analytical Sample, QC Samples, and Analytical Method

Matrix	Chemical Compounds	Analytical Methods SW 846	Primary Sample	Field QC Replicate (10%)	Field QA Replicate (10%)	Matrix Spike	Matrix Spike Duplicate	Trip Blank	Rinse Blank
Surface Soil	Explosives	8330B	46	4	4	2	2	2	4
	Metals	6010B/ 7000 Series	46	4	4	2	2	2	4
	VOCs	8260B	14	1	1	2	2	2	4
Subsurface Soil	Explosives	8330B	5	1	1	1	1	1	1
	Metals	6010B/ 7000 Series	5	1	1	1	1	1	1
	VOCs	8260B	5	1	1	1	1	1	1
Tunnel Sediment	Explosives	8330B	6	0	0	0	0	0	0
	Metals	6010B/ 7000 Series	6	0	0	0	0	0	0
Sewer Sediment	Explosives	8330B	7	1	1	1	1	1	1
	Metals	6010B/ 7000 Series	7	1	1	1	1	1	1
	VOCs	8260B	7	1	1	1	1	1	1
Powder Well Sediment	Explosives	8330B	22	2	2	2	2	0	2
	Metals	6010B/ 7000 Series	22	2	2	2	2	0	2
Surface Water	Explosives	8330B	9	1	1	1	1	1	1
	Metals	6010B/ 7000 Series	9	1	1	1	1	1	1
	VOCs	8260B	3	1	1	1	1	1	1
Direct-Push Groundwater	Explosives	8330B	16	1	1	1	1	1	2
	Metals	6010B/ 7000 Series	16	1	1	1	1	1	2
	VOCs	8260B	16	1	1	1	1	1	2
Groundwater Monitoring Well	Explosives	8330B	6	1	1	1	1	1	1
	Metals	6010B/ 7000 Series	6	1	1	1	1	1	1
	VOCs	8260B	6	1	1	1	1	1	1

Table 6-1. Summary of Analytical Sample, QC Samples, and Analytical Method (contd.)

Matrix	Chemical Compounds	Analytical Methods SW 846	Primary Sample	Field QC Replicate (10%)	Field QA Replicate (10%)	Matrix Spike	Matrix Spike Duplicate	Trip Blank	Rinse Blank
IDW Soil	Explosives	8330B	2	0	0	0	0	1	0
	Metals	6010B/ 7000 Series	2	0	0	0	0	1	0
	VOCs	8260B	3	0	0	0	0	1	0
IDW Water	Explosives	8330B	3	0	0	0	0	0	0
	Metals	6010B/ 7000 Series	3	0	0	0	0	0	0
	VOCs	8260B	3	0	0	0	0	0	0
Drilling Water	Metals	6010B/ 7000 Series	1	0	0	0	0	0	0
	VOCs	8260B	1	0	0	0	0	0	0

7.0 CALIBRATION PROCEDURES AND FREQUENCY

This section describes the calibration protocols of laboratory equipment. Field instrument calibration is described in Section 4.0 of the FSP.

7.1 CALIBRATION PROCEDURES AND FREQUENCY

Laboratory instruments and equipment will be calibrated in accordance with the requirements of the instrument manufacturer, USEPA SW-846 method protocols (USEPA, 1983b), and/or the LQAPP when SW-846 methods are not used. Measuring equipment, test equipment and all analytical instrumentation will be calibrated initially and thereafter at method or manufacturer-prescribed intervals during use.

Calibration frequency will be based on the analytical methods employed, the type of equipment, inherent stability, manufacturer's recommendations, values given in national standards and intended use and experience. Laboratory instrument continuing calibration will be performed as dictated by the USEPA method protocol.

Instrument calibration typically consists of two types:

Initial Calibration

Initial calibration procedures establish the calibration range of the instrument and determine instrument response over that range. Typically, three to five analyte concentrations are used to establish instrument response over a concentration range. The instrument response over the range is generally absorbency, peak height, etc., which can be expressed as a linear model with a correlation coefficient (e.g., for atomic absorption, inductively coupled plasma) or as a response factor or amount versus response plot (e.g., gas chromatograp/mass spectrometry).

Continuing Calibration

Continuing calibration requires measurement of the instrument response at a concentration near the mid-point for the concentration range and requires instrument response to compare with certain limits (e.g., $\pm$ 10%) of the initial measured instrument response. Continuing calibration may be used within an analytical sequence to verify stable calibration throughout the sequence and/or to demonstrate that instrument response did not drift during a period of nonuse of the instrument.

Laboratory calibration procedures and frequency are tabulated in Table 7-1. The corrective action procedures that are required if calibration checks do not meet criteria are discussed in Section 10.0.

7.2 CALIBRATION REFERENCE STANDARDS

There are two types of reference standards that analytical laboratories use for calibration. They are:

Physical Standards

Physical standards such as weights for calibration balances and certified thermometers for calibrating working thermometers and ovens are generally used for periodic calibration.

Chemical Standards

Chemical standards such as Standard Reference Materials (SRMs) provided by the National Institute of Standards and Testing (NIST, formerly the National Bureau of Standards) or USEPA. These may include vendor-certified materials traceable to NIST, USEPA, or SRMs. These are primarily used for operational calibration.

Whenever possible, physical reference standards shall be traceable to nationally recognized standards (e.g., NIST). If such national standards do not exist, the basis for the reference standard will be documented.

Physical reference standards used only for calibration will be stored separately from equipment used in analysis and these reference standards shall be at least four to ten times as accurate as the requirements for the equipment that they are used to calibrate. Physical standards are calibrated every three years by a certified external agency.

Whenever possible, chemical reference standards shall be directly traceable to NIST's SRMs. If SRMs are not available, compounds of vendor-certified high purity will be used to prepare calibration standards.

7.3 CALIBRATION FAILURES

Scheduled periodic calibration of testing equipment will not relieve laboratory personnel of the responsibility of employing properly functioning equipment. If an equipment malfunction is suspected, the device will be removed from service, tagged so it is not inadvertently used and the laboratory project manager or the project manager will be notified, as appropriate, so that recalibration can be performed or substitute equipment can be obtained.

Equipment that can no longer be calibrated or becomes inoperable during use will be removed from service and either segregated to prevent inadvertent use or tagged to indicate that it is out of calibration. Such equipment will be repaired and recalibrated or replaced as appropriate. Any such action should be documented in the laboratory log.

7.4 CALIBRATION RECORDS

Records will be prepared and maintained for each piece of calibrated equipment and each piece of reference equipment to indicate that established calibration procedures have been followed.

Table 7-1. Summary of Analytical Method Calibration Requirements

Method	Applicable Parameter	Instrument	Calibration Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8260B	VOCs	Gas Chromatograph/ Mass Spectrometer (GC/MS)	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	SPCCs average RF ≥ 0.30[c]; and %RSD for CCCs < 30%; and %RSD for all other target analytes ≤ 15%	Repeat initial calibration
			Second-source calibration verification	Once per five-point initial calibration	All analytes within ±25% of expected value	Repeat initial calibration
			Calibration verification	Daily, before sample analysis and every 12 hours of analysis time	SPCCs average RF ≥ 0.30[c]; and CCCs < 20% drift; and all contaminants of concern within ±20% of expected value	Repeat initial calibration
			Check of mass spectral ion intensities using BFB	Prior to initial calibration and calibration verification	Acceptance criteria meeting ion ratio criteria	Retune instrument and verify
SW6010B	TAL Metals	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP)	Initial calibration (according to manufacturer instructions, minimum one standard and a blank)	Daily initial calibration prior to sample analysis	<5% RSD from minimum of two replicate integrations	Correct problem then repeat initial calibration
			Initial calibration verification (ICV)	Before beginning a sample run	All analytes within ±10% of expected value	Correct problem then repeat initial calibration
			Continuing calibration verification (CCV) (Instrument Check Standard)	After initial calibration, after every 10 samples and at the end of the analysis sequence	All analyte(s) within ±10% of expected value	Repeat calibration and reanalyze all samples since last successful calibration

Table 7-1. Summary of Analytical Method Calibration Requirements (cont.)

Method	Applicable Parameter	Instrument	Calibration Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW7470A /7471A	Mercury	Cold Vapor, Flameless Atomic Absorption (AA)	Initial multipoint calibration (minimum 5 standards and a blank)	Daily initial calibration prior to sample analysis	Linear least squares regression, r ≥0.995	Correct problem then repeat initial calibration and reanalyze all samples since last successful calibration
			Second-source calibration check standard	Once per initial daily multipoint calibration	All analytes within ±10% of expected value	Correct problem then repeat initial calibration
			Calibration blank	Once per initial daily multipoint calibration	No analyte detected ≥ RL	Correct problem then reanalyze calibration blank and all samples associated with blank
			Initial calibration verification	Daily, before sample analysis	All analytes within ±20% of expected value	Correct problem then repeat initial calibration

Table 7-1. Summary of Analytical Method Calibration Requirements (cont.)

Method	Applicable Parameter	Instrument	Calibration Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8330B	Explosives	HPLC	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	Linear least squares regression, r $\geq$0.995 Linear - mean RSD of average CF of all analytes $\leq$20% and average CF of individual analyte <30% or mean RSD for all analytes $\leq$20% with no individual analyte RSD > 30%	Correct problem then repeat initial calibration and reanalyze all samples since last successful calibration
			Second-source calibration verification	Once per five-point initial calibration	All analytes within ±15% of expected value	Correct problem then repeat initial calibration
			Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time over 72 hour period	Correct problem then reanalyze all samples analyzed since the last retention time check
			Initial calibration verification	Daily, before sample analysis	All analytes within ±15% of expected value	Correct problem then repeat initial calibration
			Continuing calibration verification	Analyze a check sample and a blank immediately after calibration standards. Check and blank samples run at 1 per 10 samples and at the end of the analysis sequence	Percent difference <20%.	Correct problem then repeat initial calibration and reanalyze all samples since last successful calibration

Note:

[a] USEPA SW846, "Test Methods for Evaluating Solid Waste."

8.0 INTERNAL QUALITY CONTROL CHECKS

Internal QC checks are the procedures and methods used to evaluate the overall quality of the laboratory data generated. There are two types of internal QC, batch QC and matrix specific QC. Internal QC samples are QC samples that are generated at the laboratory, as opposed to field QC. An analytical batch is a number of samples (not to exceed 20 environmental samples plus the associated laboratory QC samples) that are similar in composition (matrix) and that are extracted or digested and analyzed at the same time and with the same lot of reagents. MS and MSD count as environmental samples. The term analytical batch also extends to cover samples that do not need separate extraction or digestion (e.g., volatile analyses by purge and trap). The identity of each analytical batch is reported with the analyses so that a reviewer can identify the QC samples and the associated environmental samples.

8.1 LABORATORY BATCH QUALITY CONTROL

Laboratory batch QC samples are those check samples, which are generated by the laboratory to evaluate the performance of the preparation, the method, and the instrumentation. Batch QC includes instrument tuning, calibration, method blanks, LCS/LCSD or BS/BSD. Instrument tuning and calibration are discussed in Section 7.0

There are two types of method blanks:

- Preparation blanks;
- Instrument blanks.

Preparation blanks are distilled/deionized water that is carried through the entire sample preparation process along with field samples in order to evaluate potential contamination from the preparation procedure. An instrument blank is an aliquot of clean reagent that is analyzed prior to samples in order to evaluate the cleanliness of the analytical system. All method blanks should be free of contamination. Criteria for evaluating the blanks and corrective actions are shown in Table 8-1.

LCS/LCSD (BS/BSD) are laboratory spiked distilled/deionized analyte free water for aqueous analysis or ottawa sand for soil analyses (except metals where glass beads of 1.0 mm diameter or smaller are used). They may be used as samples to evaluate the precision and accuracy of the preparation and analysis without interference from the sample matrix. Criteria for evaluating the LCS/LCSD (BS/BSD) and appropriate corrective actions are shown in Table 8-1.

8.2 MATRIX-SPECIFIC QUALITY CONTROL

Matrix specific QC check samples are field samples that are used to evaluating the precision and accuracy of the method. Examples of matrix QC are surrogate spikes, MS/MSDs, and laboratory duplicates. Surrogate compounds are added to each sample, if required by method, to evaluate sample preparation and analysis of each individual sample. MS/MSDs are laboratory spiked field samples that are used to evaluate the precision and accuracy of preparation and analysis for each sample matrix. In cases where spiking a sample with the analyte is not practical, precision can be evaluated through the analysis of laboratory duplicate samples. The laboratory duplicate samples are additional aliquot of an investigative sample analyzed within the same laboratory batch. Criteria for evaluating the matrix specific QC and the appropriate corrective actions are shown in Table 8-1.

Table 8-1. Summary of Laboratory Quality Control Checks and Acceptance Criteria

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8260B	VOCs	BFB Tune	Beginning of every 12-hour shift	Ion ratios must meet criteria	Retune instrument Reanalyze BFB or check BFB in calibration standards
		Initial Calibration	Prior to analysis and when continuing calibration criteria fail	5 point calibration; % RSDs for CCC compounds < criteria and RRF> criteria for selected SPCC/CCC compounds	Recalibrate instrument
		LCS for TCE and 1,2-DCE analytes	One LCS per analytical batch	QC acceptance criteria, Tables 3-2,3	Correct problem then re-prep and analyze the LCS and all samples in the affected analytical batch
		Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria, Tables 3-2,3	Correct problem then re-extract and analyze sample
		MS/MSD	One MS/MSD per every batch of USACE project samples per matrix when available	QC acceptance criteria, Tables 3-2,3	Correct problem then re-prepare and analyze all samples for out-of-control analytes in the affected analytical batch if LCS recoveries are out of control
SW 6010B	Metals	Method blank	One per analytical batch	No analytes detected ≥ 0.5POL	Correct problem then re-prep are and analyze method blank and all samples processed with the contaminated blank
		LCS	One LCS per analytical batch	QC acceptance criteria, 80-120%	Correct problem then re-prepare and analyze the LCS and all samples in the affected analytical batch
		MS/MSD	One MS/MSD per every batch of USACE project samples per matrix	Laboratory QC acceptance criteria, 75- 125%	Correct problem then reextract and analyze sample

Table 8-1. Summary of Laboratory Quality Control Checks and Acceptance Criteria (cont.)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW 7470A/ 7471A	Mercury	Method blank	One per analytical batch	No analytes detected ≥ PQL	Correct problem then re-prep are and analyze method blank and all samples processed with the contaminated blank
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Tables 3-6,7	Correct problem then re-prepare and analyze the LCS and all samples in the affected analytical batch
		MS/MSD	One MS/MSD per every batch of USACE project samples per matrix	QC acceptance criteria, Tables 3-6,7	Correct problem then re-prepare and analyze all samples for out-of-control analytes in the affected analytical batch if LCS recoveries are out of control
SW 8330B	Explosives	Method blank	One per analytical batch	No analytes detected ≥ PQL	Correct problem then re-prep are and analyze method blank and all samples processed with the contaminated blank
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Tables 3-4,5	Correct problem then re-prepare and analyze the LCS and all samples in the affected analytical batch
		Surrogate spike	very sample, spiked sample, standard, and method blank	QC acceptance criteria, Tables 3-4,5	Correct problem then re-prepare and analyze the LCS and all samples in the affected analytical batch
		MS/MSD	One MS/MSD per every batch of USACE project samples per matrix	QC acceptance criteria, Tables 3-4,5	Correct problem then re-prepare and analyze all samples for out-of-control analytes in the affected analytical batch if LCS recoveries are out of control

Note:

[a] All CAs associated with USACE project work will be documented, and all records will be maintained by the laboratory.

9.0 CALCULATION OF DATA QUALITY INDICATORS

9.1 PRECISION

Precision will be evaluated using RPD between analyses of MS/MSD (replicate field samples spiked identically by the laboratory), BS/BSD, field duplicates, and laboratory duplicates. Precision determined using RPD will be calculated as follows:

$$RPD = \frac{(C - C') \times 100\%}{(C + C')/2}$$

where C is the larger of the two values and C' is the smaller of the two values.

If three or more replicate measurements have been taken, calculate Relative Standard Deviation (RSD) instead of RPD:

$$RSD = (s/x) \times 100\%$$

where s is the standard deviation and x is the mean of replicate values.

9.2 ACCURACY

Analytical accuracy will be evaluated using the Percent Recovery (%R) results of the LCS/LCSD, BS/BSD, and MS/MSD. Accuracy as determined by the %R will be calculated as follows:

$$\%R = \frac{(A - B) X 100}{C}$$

where A= measured value of spiked sample or blank;
B= measured value of unspiked sample or blank;
C= known amount of spike in the sample or blank.

9.3 COMPLETENESS

Completeness is calculated as indicated below:

$$\% \text{ Completeness} = \frac{(V) X 100}{(N)}$$

where N= total number of measurements;

V= number of measurements meeting criteria.
(For completeness of acceptable data: V= number of measurements that were acceptable. For completeness of quality data: V= number of measurements that were not qualified).

The completeness objectives for this project are as follows:

- Completeness for sample collection;
- Completeness for quality data;
- Completeness for acceptable data.

Completeness for sample collection is defined as the percentage of specified samples listed in the FSP that were actually collected:

- Sample collection – the completeness for sample collection is 95%;
- Completeness for quality data – the completeness for quality data is 80%;
- Completeness for acceptable data – the requirement for completeness for acceptable data is 98% for each individual analytical method.

9.4 METHOD DETECTION LIMITS

MDL are determined as follows:

- Estimate the MDL using one of the following:
  - The concentration value that corresponds to an instrument signal/noise ratio in the range of 2.5 to 5, or
  - The concentration equivalent of three times the standard deviation of replicate measurement of the analyte in reagent water, or
  - The region of the standard curve where there is a significant change in sensitivity (i.e., a break in the slope of the standard curve).
- Analyze seven replicates of a matrix spike (American Society for Testing and Materials, ASTM Type II water for aqueous methods, Ottawa sand for soil methods) containing the analyte of interest at a concentration three to five times the estimated MDL;
- Determine the variance (S^2) for each analyte as follows:

$$S^2 = \frac{1}{n-1}\left[\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2\right]$$

where x_i = the nth measurement of the variable x;

$\bar{x}$ = the average value of x.

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

- Determine the standard deviation (s) for each analyte as follows:

  $s = (S^2)^{1/2}$

- Determine the MDL for each analyte as follows:

  MDL = 3.14(s)

(Note: 3.14 is the one-sided t-statistic at the 99 percent confidence level appropriate for determining the MDL using 7 samples).

10.0 CORRECTIVE ACTIONS

10.1 INCOMING SAMPLES

Problems noted during sample receipt will be documented on an appropriate form (such as the Cooler Receipt form) and TapanAm project manager will be contacted immediately. The project manager in consultation with the USACE project chemist will determine the proper corrective action. All corrective actions taken shall be thoroughly documented. Corrective actions may involve re-sampling, adding preservative, or simply noting the problem.

10.2 SAMPLE HOLDING TIMES

If samples were not extracted and analyzed within the appropriate method required holding times, TapanAm Associates project manager must be notified as soon as possible. The TapanAm project manager, in consultation with the USACE project chemist, will determine the proper corrective action. All corrective actions taken will be thoroughly documented by the laboratory and noted in the case narrative of the data report. Corrective actions may involve re-sampling or simply noting the problem.

10.3 INSTRUMENT CALIBRATION

No sample analysis will be allowed until all initial tunings and calibrations of the instruments meet the appropriate requirements (Table 7-1). All calibrations must meet method-specified frequency requirements, as given in Section 7.0 or recalibration must be performed. All continuing calibrations that do not meet method acceptance criteria, as given in Section 7.0 will result in a review of the calibration, rerun of the appropriate calibration standard(s). If corrective actions were necessary, all affected samples back to the previous acceptable calibration check will be reanalyzed.

10.4 QUANTITATION LIMITS

Any quantitation limits above the PQL shown in Tables 3-2 through 3-13 for reasons other than high target compound concentrations must be brought to the attention of the laboratory's QA manager and the project manager immediately. If difficulties arise in achieving these limits due to a particular sample matrix, the subcontract laboratory should notify TapanAm project chemist, who will confer with the USACE project chemist to resolve the matter.

Any dilution that causes change of the PQLs will be documented in a case narrative along with the revised PQLs for those analytes directly affected. Dilutions are performed if the on-column quantitation of any target compound exceeds the linear range of the calibration curve. Analytes detected above their MDL, but below the PQL, will be reported as estimated values.

10.5 METHOD QUALITY CONTROL

All method-specified QC criteria are specified Table 7-1. Failure of any method QC requirement will result in a review of all affected data. The USACE project chemist will be notified promptly to discuss possible corrective actions for resolution of unusual matrix problems.

10.6 CALCULATION ERRORS

If calculation errors or reporting errors are discovered, the data will be recalculated and reports reissued, if necessary. The case narrative of the reports must contain the reasons for the re-issuance of the revised reports. TapanAm project manager will review all reissued reports for acceptance.

11.0 DATA REDUCTION, REVIEW, EVALUATION, AND REPORTING

All analytical data generated by the laboratory will be extensively reviewed by the laboratory personnel prior to report generation to assure validity of the reported data. The laboratory's internal data review process will consists of data generation, data reduction, three levels of documented data review, and data reporting. The review process will be documented using an appropriate checklist form that is signed and dated by the reviewers. The general format of the overall data reduction, validation, and reporting is shown in Chart 11-1.

11.1 DATA REDUCTION

Data obtained by the following method or instrument are directly reportable:

- Volatile GC/MS;
- ICP metals;
- AA metals; and
- pH;

Factors that affect the final results such as sample weight, percent solids, and dilution factor are input into the instrument computer and correct results are calculated automatically. Data reduction for this project will be limited to the calculation of concentrations as described in Section 9.0. The data reduction also involves any other calculations described in the methods necessary to generate the results such as the calculation of RPD for the standards.

11.2 DATA REVIEW

The analysts who generates the analytical data has the primary responsibility for correctness and completeness of that data. Each step of this review process involves evaluation of data quality based on both the results of the QC data and the professional judgement of those conducting the review. The three levels of review are described as follows:

- Analysts will review their work based on an established set of guidelines. Review criteria as established in each method, in this QAPP, and as stated within the laboratory's QAPP will be used. The review will at a minimum ensure that:

- Sample preparation information is correct and complete;
- Analysis information is correct and complete;
- Appropriate SOPs have been followed;
- Analytical results are correct and complete;
- QC samples are within established control limits;
- Blanks and blank spikes are within appropriate control limits;
- Special sample preparation and analytical requirements have been met; and
- Documentation is complete (any anomalies have been documented and forms completed, holding times documented, etc.).

Level I

Level I data review will be documented by using a checklist form with a signature and date entered by the reviewer.

Level II

Level II review will be performed by a supervisor or data review specialist whose function is to provide an independent review of the data package. This review will also be conducted according to an established set of guidelines and will be structured to ensure that:

- All appropriate laboratory SOPs have been followed;
- Calibration data are scientifically sound, appropriate to the method and completely documented;
- QC samples are within established guidelines;
- Qualitative identification of sample components is correct;
- Quantitative results are correct;
- Documentation is complete and accurate (any anomalies have been documented and forms completed, holding times documented, etc.);
- Data are ready for incorporation into the final report; and
- The data package is complete and ready for archive.

Level II review will be structured so that all calibration data and QC sample results are reviewed and all of the analytical results from at least ten percent of the samples are checked back to the sample preparation and analytical bench sheets. If no problems are found with the data package, the level II review is complete. If any problems are found with the data package, an additional ten percent of the sample results will be checked back to the sample preparatory and analytical bench sheets. This cycle then repeats until ether no errors are found in the data set checked or all data have been checked. All errors and corrections noted will be documented. Level II data review will be documented on a checklist with the signature and date of the reviewer.

Level III

Level III review will be performed by the quality assurance manager or the program administrator at the laboratory. This review will be similar to the review as provided in Level II except that it will provide a total overview of the data package to ensure its consistency and compliance with this QAPP. All errors noted will be corrected and documented. Level III data review will also be documented on a dated checklist with the signature of the reviewer.

11.3 DATA EVALUATION

All data evaluations reference the USACE's *CENWK-EP-ES Data Quality Evaluation Guidance* (1999). The data qualifiers for definitive data are listed in Table 11-1.

11.4 DATA REPORTING

Data reports are required to include certain elements. These elements are provided as requested in this order:

- Title sheet with project name, contract number, lab name and address, point-of-contact, phone/fax number, and signature of a responsible party;
- Case narrative with number and description of samples, tests performed, problems encountered, corrective actions, and general comments. A table summarizing sample identifications (IDs), laboratory IDs, batch numbers, and associated QC samples is desired, but optional;
- Summary forms that would summarize the surrogate recoveries (if required by method), MS/MSD results (if require by method), method blank form showing samples associated and dates/times of analysis, QC samples out-of-control along with the corrective actions, and calibration check summaries;
- Analytical data arranged by analytical method and by sample within each method type, which will include at least the following for each sample:

- Sample results form indicating sample quantitation limits (SQLs);
- Copies of chromatograms;
- Quantitation reports;
- Instrument printouts (optional);

- Calibration data (optional);
- Method detection limits and dilutions;
- QC data results form showing control limits;
- COC form;
- Level I, II, and III data review checklists, signed and dated (optional);
- Copies of pertinent notebook pages showing analyst notes and corrective actions (optional).

11.5 QUALITY CONTROL SUMMARY REPORT

A QCSR will be prepared and submitted to summarize the results of the data validation effort and to present the sample analysis results in tabular format. The QCSR will be submitted to USACE prior to writing the draft PA/SI. The format of the QCSR will be as described Section 14.2.

Chart 11-1. General Format of the Overall Data Reduction, Validation, and Reporting Scheme

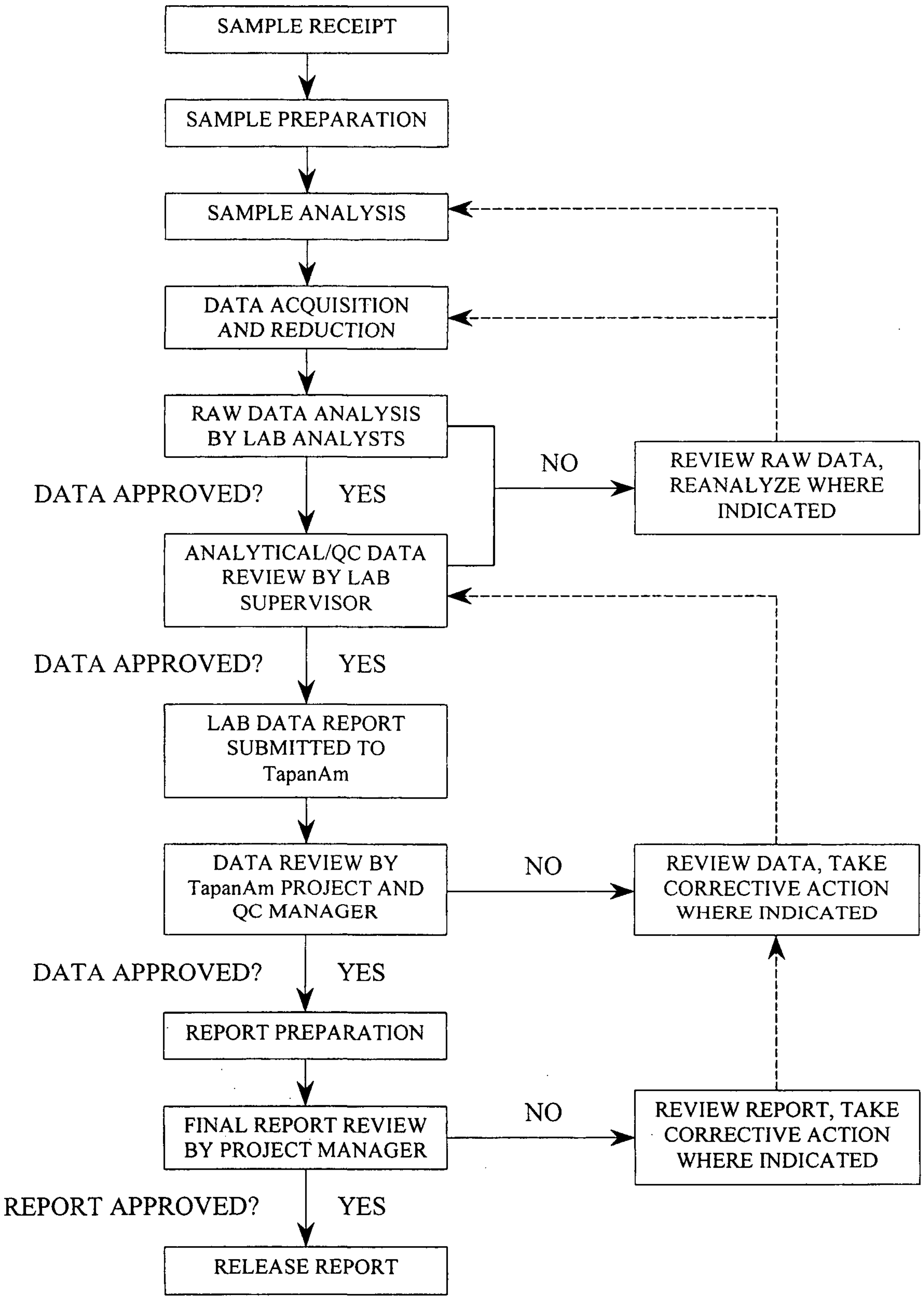


Table 11-1. Data Qualifiers

Qualifier	Description
J	The analyte was positively identified, the quantitation is an estimation.
U	The analyte was analyzed for, but not detected. The associated numerical value is at or below the MDL.
R	The data are unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.

12.0 PREVENTIVE MAINTENANCE

To minimize downtime and interruption of analytical work, preventive maintenance will be routinely performed by the laboratory personnel on each analytical instrument. Designated personnel will be trained in routine maintenance procedures for all major instrumentation. When repairs are necessary, either trained staff or trained service engineers employed by the instrument manufacturer will perform them. Maintenance contracts will be maintained on all major analytical instruments. All maintenance or repairs conducted will be detailed within logbooks, unique to each instrument. A maintenance schedule will be established and posted for each instrument, as well as a spare parts list. Backup instrumentation will be designated in case of an extended breakdown for a piece of analytical instrumentation. It is the responsibility of the laboratory to have a backup plan in force such that all sample holding times can be met.

12.1 LABORATORY EQUIPMENT MAINTENANCE

All major equipment used at the laboratory will be covered by a service contract. Laboratory equipment requiring routine maintenance will have a maintenance schedule indicating the date of required maintenance, persons maintaining the equipment and the next maintenance date. Information pertaining to life histories of equipment maintenance will be kept in individual logs for each instrument at the subcontracted laboratories.

Major instruments in the laboratories will be covered by annual service contracts with manufacturers. Under these agreements, trained service personnel will make regular preventive maintenance visits. Maintenance is documented and maintained in permanent records by the individual responsible for each instrument. A listing is maintained of the critical spare parts that should be on hand to minimize equipment downtime. Specific laboratory and field equipment preventive and maintenance practices, frequency, and spare parts are presented in the LQAPP.

12.2 MAINTENANCE SCHEDULE

Regular inspection, cleaning, servicing and maintenance of analytical equipment will be performed according to manufacturer's recommendations. The preventive maintenance schedule varies with the type of instrument. The analysts responsible for the particular instruments will perform preventive maintenance.

13.0 PERFORMANCE AND SYSTEM AUDITS

Audits are performed to ensure and document that the procedures set forth in this QAPP are used to provide data of acceptable quality, and that subsequent calculations, interpretation, and other project outputs are checked and validated. Performance audits are conducted to ensure that data measurements are accurate. Based on the audit results, the QC manager in conjunction with the project manager may issue requirements for corrective actions. The types of system and performance audits to be performed include facilities and equipment, analytical laboratory, and data handling.

The QA manager or designee will perform any audits deemed necessary by the USACE project chemist. Quality assurance audits and surveillance are conducted to assess the performance of laboratory systems in meeting technical, regulatory and client requirements. The laboratory performs regular system and performance audits, and these are described in their LQAPP. The selected laboratory has successfully completely analysis of Chemical Quality Assurance Branch Laboratory (CQAB Lab) performance evaluation samples for the required analyses.

13.1 PERFORMANCE AUDITS

Audits can be internal or external. Results from these external and internal audits are used to continually monitor laboratory performance and correct any out-of-control situations.

Internal performance audits will be planned and executed by the laboratory QA manager at least annually. These audits will consist of a combination of blind QC check samples, SRM, known standards, and blind spike samples. Audit samples are treated as actual samples and logged in as client samples. Performance audits will cover all of AM Lab's service areas. Upon completion of the audits, any areas of concern will be reviewed and appropriate corrective action will be implemented to alleviate the problems.

External performance audits are performed semiannually. AM Lab participates in the following external audit programs:

- EPA Water Pollution Audit Program;
- USACE Laboratory Validation Program;
- Analytical Products Group (APG) Laboratory of Excellence Performance Evaluation; and

- National Institute for Occupational Safety and Health's (NIOSH) Environmental Lead Proficiency Analytical Testing (ELPAT) Program.

The performance audits are in the form of blind performance evaluation samples submitted by the auditing agency. AM Lab is validated by USACE and has successfully completed analysis of CQAB samples.

The laboratory QA manager has overall responsibility of monitoring the internal QA/QC program, scheduling and coordinating external audits, and reviewing data for performance samples received. He has staff to provide in-house audits and review analytical data packages. He supplies blind performance samples to the laboratory at least semiannually.

The laboratory QA manager and support staff audit the laboratory systems and procedures at a 12-18 month review cycle. Unique client audit procedures and data requirements will be complied with as contractually specified. The internal audit consists of a review of laboratory systems, procedures, and documentation (detail is in the LQAPP). Any deficiencies and/or deviations are documented, and a summary report is prepared.

13.2 SYSTEM AUDITS

Details of system audit checklists are included in the LQAPP. System audits can be internal or external as described below:

- Internal system audits will be planned and executed either by the laboratory QA manager or by an audit team at least once a year. The audit will determine whether QC standards such as blanks, LCS, MS, duplicates, etc., are incorporated with sample analytical runs at the needed frequency. The audits will involve extensive interviews of the analysts designed to improve and implement more effective procedures, evaluate training needs, and to address resource requirements. At the conclusion of the audit, the laboratory QA manager will provide a written report to the field site manager along with a copy to the laboratory manager for consideration of any recommended corrective action;
- External audits are performed annually or at a frequency designated by the certifying agencies and clients. Currently, CQAB Lab audit the laboratory on a regular basis. The laboratory QA manager or laboratory manager will coordinate all external audits.

14.0 REPORTS TO MANAGEMENT

All raw data will be stored by AM Lab for two years after project samples have been analyzed.

14.1 DATA REPORTS TO THE USACE

Copies of laboratory reports will be submitted to USACE. The test data will include, as a minimum, a complete set of QC data (BS/BSD, MS/MSD, surrogates, etc.) and sample data.

In addition, QC summaries and copies of pertinent raw data will be supplied to the Chemistry Quality Assurance Branch of the Waterways Experiments Station Environmental Laboratory (CEWES-CQAL) and USACE within 45 days of the receipt of the results from the laboratory. The submittal to the CQAB Lab will include samples associated with the QA replicate and their associated field and laboratory QC. The following detailed information will be submitted:

Sample Identifications

A tabular presentation that matches contract laboratory sample IDs to QA laboratory sample IDs. This table will also identify all field duplicates and field-generated blanks (rinsate and trip blanks) and indicate associations with their corresponding field samples.

Sample Receipt

A copy of the completed Cooler Receipt Form (Figure 5-1) for all shipments.

Case Narrative

The laboratory case narrative for each data package generated.

General Organic and Inorganic Reporting

For each analytical method run, all analytes for each sample as a detected concentration or less than the sample specific limits of quantitation (such as SQL) will be reported. Analyte concentrations above the MDL but below the sample quantitation limit will be flagged as estimated. Non-detects will be reported as a numerical value with a "U" flag. Soil/Sediment and solid waste samples will be reported on a dry-weight basis with percent moisture also reported.

Dilution factors for each sample as well as the date of extraction (if applicable) and date of analysis will be reported.

Internal Quality Control Reporting

The following information will be included:

- Method Blank – All analytes will be reported for each method blank. All non-blank sample results will be designated as corresponding to a particular method blank in terms of analytical batch processing;
- Surrogate Spike Sample – Surrogate spike recoveries will be reported with all organic method reports when the method requires surrogates. The report will also specify the control limits for surrogate spike results as well as the spiking concentration. Any out-of-control recoveries will results in the sample being rerun; if QC limits cannot be met in the second run, both sets of data are to be reported and the data to be flagged. Surrogate recoveries are to be reported for all samples and all QC samples (field and laboratory in origin);
- MS Sample – MS recoveries will be reported for all organic and inorganic analyses. All sample results will be designated as corresponding to a particular matrix spike sample. The report will indicate what field sample was spiked even if it was not a USACE project sample. The report will also specify the control limits for matrix spike results for each method for each matrix;
- Laboratory Duplicates and/or MSD Pairs – Relative percent difference values will be reported for all duplicate pairs as well as analyte/matrix specific control limits;
- Laboratory Control Sample (LCS) – LCS results will be reported with the corresponding field sample data when required by the analytical method and/or the project. Control limits for LCS will also be specified. The LCS will not be substituted for MS/MSD samples;
- Field Duplicate and Rinsate Blank – These samples will be identified and reported as any other field sample. Relative percent differences will be reported for all field duplicate pairs.

14.2 QUALITY CONTROL SUMMARY REPORT

A QCSR will be prepared and submitted to the USACE. The QCSR will accompany the analytical data package. The following sections describe the minimum elements that will be included in the QCSR.

14.2.1 Data Collection

This section will include the following information and data:

Sampling Procedures

Any deviations from the FSP and QAPP, and resultant effects on the data will be described.

Sample Handling and Custody

Any deviations from the FSP and the QAPP in sample handling and custody, the resultant effect on data collected, and rationale for the deviation will be described.

Equipment Calibration and Maintenance

If any changes were made to the procedures in the QAPP, a detailed description of the actual procedure used will be provided and the reasons for making changes will be discussed.

Analytical Procedures

For standard methods, the analyte and the corresponding method number will be listed. If any modifications were made to the standard methods, a rationale and detailed description the changes will be provided. Any non-standard methods approved by USACE but not previously described in the QAPP will be discussed in the QCSR:

- Method Applicability – The specific chemicals or classes of chemicals and appropriate concentration ranges and matrixes will be indicated;
- Sensitivity – The sensitivity and detection limit of the method will be sufficient for the purpose of the analyses (normally ppb to ppm);
- Interferences – Interferences determined or suspected to be the cause of any elevated detection/quantitation limits will be listed and efforts made to minimize these interferences will be described;
- Apparatus – Changes in instrumentation (make and model, including detectors), operating parameters (including chromatography columns, if applicable), and chemicals (state source and purity) will be described;

- Standards – Changes from the QAPP will be described. Calibration standards will be included;
- Procedures – Any changes in extraction, analysis, and validation of the method for the matrixes in question (e.g., method blanks, calibration checks, recoveries, reference standards, replicate analyses, split samples, spiked samples, standard additions, etc.) will be described.

14.2.2 Data Analysis and Validation

The statistical procedures used in the assessment of data, including the use of control limits, if applicable, will be discussed. Any results that seem to show bias or larger-than-expected standard deviations will also be discussed. The following summaries will be provided in the QCSR:

Positive Analytical Results

A positive analytical result summary will be provided that indicates matrix, analytes, and concentrations for various sampling locations. It will consist of a table of analytical results (positive detections only) by client sample ID and laboratory sample ID and a minimum of one map showing client sample IDs and locations. When data are sparse enough to avoid visual clutter, map(s) only, which show sample locations, IDs, and analyte identity and concentrations, will be presented.

Contract Laboratory Quality Control Analysis Results

QC results that are outside established criteria will be tabulated, and the established criteria will be listed next to the result. QC results that are within criteria do not have to be listed separately, and can be summarized by number. Comments will be included on how these data affect the validity of analytical results of the samples.

System Audits

Any inspections will be reported with indication that when the inspection was performed, by whom, deficiencies encountered, and corrective actions taken.

Chemical Analytical and QA/QC Problems Encountered

This section in the QCSR report will indicate the degree to which each analytical system met or failed to meet the data quality objectives in the QAPP.

14.2.3 Appendices

The appendices in the QCSR report will include the following information:

Data

The analytical data will include the client ID number (sample number) with corresponing laboratory ID number.

Documentation

The documentation will include examples of each type of documentation used to control data collection, labeling, analysis, and reporting. The appendix, however, will include complete copies of all of the following documents:

- COC forms;
- Cooler Receipt forms;
- Daily Quality Control Reports.

15.0 REFERENCES

Battelle, 1981. United States Army Toxic Hazardous Materials Agency (USATHAMA). Survey of Hazardous/Chemical Area No.2 of the Former St. Louis Ordnance Plant. June, 1981. Columbus Battelle Laboratories

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